New Scientist

WEEKLY 8 June 2024

TIME MAY BE A QUANTUM ILLUSION

WHY TOO MUCH POSITIVITY CAN BE BAD FOR YOU

CAN GOOGLE TAME ITS AI SEARCH TOOL?

THE SALT FIX

The surprisingly simple way to satisfy your cravings without damaging your health

PLUS
WEIRD MATERIALS THAT REWIND LIGHT
ANCIENT EGYPTIAN CANCER TREATMENT
BIGGEST GOOSE THAT EVER LIVED

No3494 £6.95 CAN$9.99

ROLEX
Perpetual Planet Initiative

DENICA RIADINI-FLESCH
NEW ROLEX AWARDS LAUREATE

Fields of possibilities. Denica Riadini-Flesch's ambition is to help provide fair living and working conditions for artisan women in Indonesia. This Indonesian economist set up a company specializing in sustainable clothing production from farm to closet. The project, both environmentally friendly and based on circular economy principles, has led to a 60 per cent average increase in women's earnings – women being the primary workforce in this industry in Indonesia. Her Rolex Award for Enterprise will help her endeavours to triple the number of craft schools with the aim of reaching 10,000 lives by 2030.

#Perpetual

OYSTER PERPETUAL
EXPLORER 40

ROLEX

Only the *finest* *varieties are expertly selected to make* ***Tesco Finest Berries*** *irresistibly sweet.*

...Just so you can tart up your pudding.

Serving Suggestion. Available in the majority of larger stores.

TESCO finest

This week's issue

On the cover

32 The salt fix
The surprisingly simple way to satisfy your cravings without damaging your health

Vol 262 No 3494
Cover image: Lisa Sheenhan

10 Time may be a quantum illusion

36 Why too much positivity can be bad for you

16 Can Google tame its AI search tool?

40 Weird materials that rewind light **21** Ancient Egyptian cancer treatment **14** Biggest goose that ever lived

36 Features

"Emotions that are helpful and meaningful often don't feel pleasant"

News

11 Bird flu risk
Low chance of the outbreak in cows causing a pandemic

13 Homeward bound
China's moon lander stores rock samples and takes off

15 Up the spout
Cleaner ship emissions may warm the planet faster than we expected

Views

23 Comment
Racism can cause real harm to body and mind, says Layal Liverpool

24 The columnist
Graham Lawton on the benefits of wood in construction

26 Aperture
An unusual look at an anglerfish

28 Culture
An impressive book dissects consciousness

31 Letters
Ageism is alive and well

POL FERNANDEZ

17 The home of a fern Expedition discovers plant with a giant genome

Features

32 Secret salt
A more palatable option in our war against dietary sodium

36 The happiness trap
Has the idea that we should always look on the bright side gone too far?

40 Backwards stuff
Strange new materials that act like a mirror in time are a testing ground for exotic physics

The back pages

44 Debunking gardening myths
Does milk fertilise houseplants?

45 Puzzles
Try our crossword, quick quiz and logic puzzle

46 *Almost* the last word
Is it more eco-friendly to keep an old car or buy a new EV?

48 Feedback
Canine contributions, plus a mustache mix-up

48 Twisteddoodles for *New Scientist*
Picturing the lighter side of life

Elsewhere on New Scientist

NS Live

Climate future

Having alerted the world to the threats posed by climate change, scientists need to build solid foundations for new research that is robust and relevant to society, says physicist and climate philosopher David Stainforth. Hear him explore whether complicated computer models are the right approach to learning about the future climate at New Scientist Live on 13 October at London's ExCeL Centre.

newscientist.com/nslmag

Tour

Arctic expedition: Svalbard, Norway

Explore the Arctic with evolutionary biologist Richard Dawkins. Cruise the Norwegian archipelago of Svalbard and enjoy shore visits, boat safaris and talks covering glaciology, astronomy, marine biology, botany and the history of polar exploration. This 12-day tour starts on 22 June 2025 and costs £12,236.

newscientist.com/tours

Podcast

Weekly

The team discuss how chickens may understand something about language that we thought was specific to humans. They also investigate why time may be a quantum illusion and how seaweed can help with a green energy conundrum. Plus, the lowdown on Google's AI search engine mishap and a Nobel prizewinning biologist on the latest in the science of ageing.

newscientist.com/nspod

JUERGEN RITTERBACH/ALAMY

Arctic expedition Enjoy tundra hikes amid beautiful scenery

RAVI DEEPRES

Autobiography AI can be a choreographer's creative partner

Video

Creative intelligence

In the most recent iteration of the dance performance *Autobiography*, choreographer Wayne McGregor weaves memoir with data from his own DNA. He has also trained an algorithm on hundreds of hours of his choreographic archive and used it to develop new movements for the dancers in his company. "We use science to do something really interesting creatively," he says.

youtube.com/newscientist

Newsletter

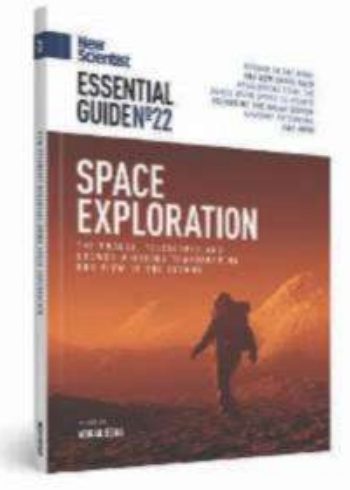
Launchpad

Space reporter Leah Crane reveals all there is to know about wormholes. We still don't have evidence that these strange tunnels in space-time really exist, but there is new research on whether they could be out there, how we might be able to spot them and what happens when matter spirals into them.

newscientist.com/launchpad

Newsletter

"If matter falls into a wormhole, it gets stuck and turns into a blazing tornado of plasma"



Essential guide

What drives us to explore space? Are we returning to the moon for the wrong reasons? How are space probes rewriting our origin story? Discover the history and future of exploration beyond Earth in this *New Scientist Essential Guide*, now available to read in the app or buy in print from our online shop.

shop.newscientist.com

You understand the power of science. You value facts and evidence over popular opinion. Medical research is your greatest gift to future generations.

Medical Research Foundation

Get your guide to gifts in Wills

We need people like you – who understand the power of science – to fund the research that will change lives in the future.

By leaving a gift to the Medical Research Foundation, you'll be funding the research that future generations will depend on. The Medical Research Foundation is an independent charity, focused solely on funding quality medical research. With close links to the Medical Research Council, we're able to choose the most impactful studies and adapt quickly to meet any emerging health crisis – thanks to the support of people like you.

Your Will can support some of the brightest scientific minds.

Many of these scientists are at the beginning of their careers, when funding is hardest to secure. Your support at this critical time can provide the springboard a scientist needs to drive their research and career forward, ensuring they can continue to make life-changing discoveries for many years to come.

Thanks to gifts in Wills, the Medical Research Foundation has supported researchers tackling pressing challenges like the COVID-19 pandemic and the threat of antimicrobial resistance, as well as vital areas of research that are often overlooked by other funders – ensuring we fill the gaps in our medical knowledge and protect the future of human health.

We have seen how quickly global health crises can arise, and how much we depend on the brightest scientific minds to offer a way out.

As someone interested in science, you will understand that while no one can predict what we will face next, we can be certain that it is only through ambitious, high-quality medical research that we will meet whatever new challenges come our way.

By leaving a gift in your Will, you can have a lasting impact on science and on the future of human health in the UK.

@MedResFdn
@MedResFdn
Medical Research Foundation

Scan this QR code to find out more

Leave a legacy of scientific thought. Remember the Medical Research Foundation with a gift in your Will.

To request your guide to gifts in Wills fill in this form and return to The Medical Research Foundation, 99 Charterhouse Street, London, EC1M 6HR **OR** visit **medicalresearchfoundation.org.uk/support-us/wills**

Name _____

Address _____

_____ Postcode _____

Email address _____

Medical Research Foundation

Registered with FUNDRAISING REGULATOR

We would like to contact you from time to time with our latest news. Please tick here ☐ if you are happy for us to contact you via email. We will not share your personal information. You can unsubscribe at any time. For further information on how we collect, store and process your personal data, please read our Privacy Notice medicalresearchfoundation.org.uk/privacy

0224NEW

Medical Research Foundation is a charity registered in England and Wales (Reg. Charity No. 1138223).

World Oceans Day

Jason Momoa
UNEP Advocate for Life Below Water

On World Oceans Day, dare to imagine an **ocean free of plastic pollution**

Act now to beat plastic pollution. Learn about the global effort to tackle single-use plastics and how to make a difference.

With trillions of floating pieces of plastic in the open ocean today, it can be hard to recall life before the age of plastic waste. My home island, Hawaii, has some of the world's dirtiest beaches, with fish eating plastic particles just days after being born — no surprise given that nearly two-thirds of all plastic becomes waste after a single use.

Plastic pollution damages humanity

I took a vow to go after single-use plastic, not only because it's ugly but because it is killing us. It is in our food and blood vessels. Plastics are on track to emit almost one-fifth of global greenhouse gases, making beating plastic pollution a key part of ensuring a liveable climate.

Turning off the tap on plastic pollution requires joint efforts by governments, cities, the finance sector and businesses, including 20 million waste pickers worldwide, Indigenous Peoples and civil society organisations. This is why I support the UN Environment Programme (UNEP) campaign to beat plastic pollution.

International treaty to end plastic pollution

Delegates from across the world have been negotiating since 2022 to establish an international legally binding agreement to end plastic pollution, including in the marine environment. A final round of negotiations is set to take place in November this year in Busan, South Korea.

To deliver its promise, a plastics treaty must support zero-waste initiatives; offer subsidies and taxes to incentivise innovative technologies and disincentivise plastic production; have time-bound targets to eliminate unnecessary single-use, short-lived and problematic plastics; boost the redesign of products to make reuse easier; strengthen recycling; and put the responsibility of cleaning up the remaining pollution on those who keep up production. These essential policies would shift us towards a circular economy.

Turning off the tap on plastic pollution requires joint efforts.

As with any historical correction, breaking away from plastic pollution would result in many winners while plastic polluters must be on the losing side. Ultimately, they will adapt to a new way of doing business, and their children and grandchildren will benefit from a world free of plastic pollution.

Unprecedented satellite technology helps protect the ocean

Satellite technology is facilitating crucial steps to increase transparency of previously unmapped fishing and shipping activities to improve ocean governance.

For years, Global Fishing Watch has catalogued vessel movements on its flagship map using satellite data and machine learning. It is now working with governments to use that information to help regulate coastal and international waters.

Satellite mapping of ocean industrial activity

Research led by Global Fishing Watch and published in the scientific journal Nature this year highlighted an unprecedented view of previously unmapped industrial use of the ocean.

The study, 'Satellite Mapping Reveals Extensive Industrial Activity at Sea,' used machine learning and 2 million gigabytes of satellite imagery to create the first global map of vessel traffic and offshore infrastructure, revealing that 75% of the world's industrial fishing vessels are not publicly tracked.

The nonprofit's mission is to advance ocean governance through increased transparency of human activity at sea by sharing information, map visualisations and data to help inform decisions. Director of Research and Innovation, David Kroodsma, says: "Our goal is to increase transparency in the ocean to help govern it better."

While Google Maps offers satellite images of almost all land structures and roads, it is not the same with the ocean. By making data public and freeing that information for accountability purposes, that can change.

International agreements

Historically, the biggest impact on the oceans has been fishing, but shipping and offshore energy are growing exponentially and impacting ecosystems. Charles Kilgour, Director of Programme Initiatives, warns that failure to act could see collapsed fish stocks and damage to food security and livelihoods.

Global Fishing Watch advocates for an international vessel tracking agreement. Moreover, it has advanced understanding of fishing activity, promoted transparency in ocean operations and developed a vital scientific mapping tool.

Kilgour says: "In 2012, the only way to see what was happening in a country's waters was to send out patrol boats. Now, fishery managers can use our map to see what's taking place across their waters, and their understanding of what is happening has completely changed." For the nonprofit, the next step is to go from mapping to sustainably managing marine activities.

Charles Kilgour
Director of Programme Initiatives, Global Fishing Watch

David Kroodsma
Director of Research and Innovation, Global Fishing Watch

WRITTEN BY
Mark Nicholls

Find out more at **globalfishingwatch.org**

Paid for by **Global Fishing Watch**

Global Fishing Watch

Salt solution

A simple addition to table salt could solve a serious public health problem

BACK in 1960, most of the world's population was deficient in the micronutrient iodine, with severe consequences for public health. By 2020, only 21 countries were iodine-deficient – down from 113 in 1990 – and 90 per cent of people were consuming enough.

The solution? Adding iodine to table salt. Iodisation of the salt supply was strongly supported by the salt industry and governments, and is arguably one of the most effective public heath interventions of all time.

In 2024, the world is facing a similar public health crisis. High blood pressure, or hypertension, is the leading cause of illness and death. A major contributory factor is excessive consumption of sodium, which elevates blood pressure.

But as we report on page 32, new research suggests a similarly straightforward fix is at hand: potassium-enriched salt.

That could be a game changer because efforts to reduce sodium intake have failed for various reasons, not least because people like salty foods.

"Only 14 per cent of people get enough potassium. Almost everyone eats too much sodium"

Governments and industry must also shoulder some blame. Processed food manufacturers have been slow to enact salt reduction targets while the salt industry has tried to cast doubt on the efficacy and safety of salt reduction, in part by promoting the idea that getting too little is as harmful as having too much.

In any case, the latest scientific insights have put a new solution on the table. Switching to potassium-enriched salt would be a win-win, reducing sodium and also increasing consumption of potassium. This would have a greater impact on blood pressure than just cutting sodium intake alone, according to the latest research. Only 14 per cent of people get enough potassium. Almost everyone eats too much sodium.

If industry won't act on these insights voluntarily, governments should force the issue. The consequences of hypertension cost healthcare systems a fortune. Enriching salt with potassium, just as we did with iodine, offers a surprisingly palatable way to save lives and money. ▮

PUBLISHING & COMMERCIAL
Commercial and events director Adrian Newton

Display advertising
Tel +44 (0)203 615 6456 **Email** displayads@newscientist.com
Sales director Justin Viljoen
Account manager Mila Gantcheva
Partnerships account manager David Allard

Recruitment advertising
Tel +44 (0)203 615 6458 **Email** nssales@newscientist.com
Recruitment sales manager Viren Vadgama
Key account manager Deepak Wagjiani

New Scientist Events
Tel +44 (0)203 615 6554 **Email** live@newscientist.com
Sales director Jacqui McCarron
Sales manager Maureen Ignacio
Head of event production Martin Davies
Head of product management (Events, Courses & Commercial Projects) Henry Gomm
Marketing manager Emiley Partington
Events and projects executive Georgia Hill
Events team assistant Olivia Abbott

New Scientist Discovery Tours
Director Kevin Currie
Senior product manager Lara Paxton

Marketing & Data
Marketing director Jo Adams
Head of campaign marketing James Nicholson
Digital marketing manager Jonathan Schnaider
Campaign marketing coordinator Charlotte Weeks
Junior marketing designer Ruby Martin
Head of customer experience Emma Robinson
Head of CRM & audience data Rachael Dunderdale
Senior email marketing executive Natalie Valls
Email marketing executive Ffion Evans
Marketing executive Naomi Edge
Junior analyst Hamied Fahim

Technology & Product
Head of strategy and product development Clarissa Agnew
Director of strategic programmes and technology Jennifer Chilton
Head of engineering Tom McQuillan
Senior developer and UX designer Amardeep Sian
Senior developers Maria Moreno Garrido, Piotr Walków
Lead digital designer and developer Dan Pudsey
Front end developer Damilola Aigoro
Junior front end developer Matthew Staines

Partnerships
Consultant Editor Justin Mullins

NewScientist
Chief executive Roland Agambar
Chief operating officer Jonas Hermans
Chief financial officer Amee Dixon
Chair Nina Wright
Executive assistant Lorraine Lodge

Finance & operations
Head of finance Charlotte Lion
Senior finance analyst Charlie Robinson

Human resources
HR business partner Purnima Subramaniam

CONTACT US
newscientist.com/contact

General & media enquiries
UK **Tel**+44 (0)203 615 6500
9 Derry Street, London, W8 5HY
Australia 58 Gipps Street, Collingwood, Victoria 3066
US 600 Fifth Avenue, 7th Floor, NY 10020

UK Newsstand
Marketforce UK Ltd
Email mfcommunications@futurenet.com

Syndication
Tribune Content Agency **Tel** +44 (0)20 7588 7588
Email tca-articlesales@tribpub.com

Subscriptions
newscientist.com/subscription
One year print subscription (51 issues) UK £270
Tel +44 (0)330 333 9470
Email subscriptions@newscientist.com
Post New Scientist, Rockwood House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH

© 2024 New Scientist Ltd, England. New Scientist is published weekly by New Scientist Ltd. ISSN 0262 4079. New Scientist (Online) ISSN 2059 5387. Registered at the Post Office as a newspaper and printed in England by Precision Colour Printing Ltd

recycle
When you have finished with this magazine please recycle it.

EDITORIAL
Editor Catherine de Lange
Executive editor Timothy Revell
News and digital director Penny Sarchet
Creative director Craig Mackie

News
News editor Jacob Aron
Assistant news editors Chris Simms, Alexandra Thompson, Sam Wong
Reporters (UK) Madeleine Cuff, Michael Le Page, Chen Ly, Matthew Sparkes, Alex Wilkins, Clare Wilson, (Aus) Alice Klein

Digital
Acting head of digital Matt Hambly
Podcast editor Rowan Hooper
Head of editorial video David Stock
SEO and analytics manager Finn Grant
Social media manager Isabel Baldwin
Trainee video producer Obomate Briggs

Features
Head of features Daniel Cossins and Helen Thomson
Editors Abigail Beall, Kate Douglas, Alison George, Joshua Howgego, Thomas Lewton
Feature writer Graham Lawton

Culture and Community
Comment and culture editor Alison Flood
Senior culture editor Liz Else

Subeditors
Chief subeditor Eleanor Parsons
Bethan Ackerley, Tom Campbell, Tom Leslie, Jon White

Design
Art editor Ryan Wills
Joe Hetzel, Phoebe Watts

Picture desk
Picture editor Tim Boddy
Assistant picture editor Jenny Quiggin

Production
Production manager Joanne Keogh
Production coordinator Carl Latter

New Scientist US
US Publisher Tiffany O'Callaghan
US editor Chelsea Whyte
Editors Sophie Bushwick, Molly Glick
Subeditor Alexis Wnuk
Deputy audience editor Gerardo Bandera
Reporters Leah Crane, James Dinneen, Jeremy Hsu, Karmela Padavic-Callaghan, Christie Taylor, Grace Wade, Corryn Wetzel

Subscriptions

NewScientist

Pay just

£1

a week

Where will your curiosity take you?

With unlimited digital access, find health insights that challenge the way you think about your body and diet.

Begin your journey of discovery at

newscientist.com/curiosity

or call +44 (0) 330 333 9470, quoting 21192

'Print and digital' package also available. These are auto-renewing subscriptions, in the unlikely event that you wish to cancel your subscription, you can do so within the trial period and no further payment will be taken. In addition, we offer a 14-day cooling off period after the initial payment is made and will refund any unclaimed issues. Offer ends 2 July 2024.

Scan me to subscribe

News

Prehistoric pictures
Carvings of snakes are largest known rock art in the world **p12**

Chaos captured
Stunning image shows plasma's turbulence **p13**

Early onset
Why is menstruation occurring ever earlier in the West? **p14**

Bug hunters
AIs help people claim rewards for finding software errors **p20**

Spiky logic
Baby chicks link sounds and shapes just like we do **p21**

MATTHEW SHERMAN

Palaeontology

A gentle giant ready to attack

Meet Apex, the biggest and most complete Stegosaurus fossil ever found. Discovered in Colorado in 2022, the skeleton – with its tail now set in an attack pose – is over 3 metres tall and 6 metres long, and has 247 bones. This herbivorous dinosaur is thought to have lived some 150 million years ago in the Jurassic period. It is expected to fetch $4 million to $6 million when auctioned by Sotheby's on 17 July.

Physics

Time may be a quantum illusion

If nature is genuinely quantum, time may arise from the entanglement that links together quantum objects, reports **Karmela Padavic-Callaghan**

TIME may not be a fundamental element of our physical reality. New calculations add credence to the idea that it emerges from quantum entanglement, in which two objects are so inextricably linked that disturbing one disrupts the other, no matter how distant they are.

"For centuries, time has entered physics as an essential ingredient that is not to be questioned. It is so deeply rooted in our conception of reality that people thought that a definition of time was not needed," says Alessandro Coppo at the National Research Council of Italy.

This perception began to change in the 1900s, when theories of quantum physics and general and special relativity offered conflicting views on time.

In general relativity, time is baked into the fabric of the universe – our physical reality is set in space-time. Under this theory, time can warp and dilate in the presence of gravity. On the other hand, quantum theory treats time as something that isn't malleable and doesn't change like other properties of a quantum object – recording the passage of time requires an observer to consult a clock external to this object.

General relativity and quantum theory describe objects at vastly different scales, such as stars and atoms, but because these all exist within the same universe, many physicists believe that the conception of time should be consistent across them. Coppo and his colleagues went hunting for such a single notion.

To get there, they put a promising but strange idea from the 1980s through several mathematical tests. At its core is the suggestion that when we see an object change over time, that is only because that object is entangled with a clock. That means a truly external observer standing outside the entangled system would see a completely static, unchanging universe. Within this framework time isn't a given, but purely a consequence of entanglement.

In their mathematical model, Coppo and his colleagues represented the clock as a system of theoretical tiny magnets, which are entangled with a quantum oscillator, or a quantum version of a spring. The researchers chose these as models because they are well understood mathematically, so they made for a clear theoretical test case and set the stage for possible experimental tests later.

They found that their system could be described by a version of the famous Schrödinger equation, which is used to predict the behaviours of quantum particles – with one crucial difference. Where the Schrödinger equation would contain a variable that we call time, the new equation had a variable that enumerates the quantum states of the magnets (*Physical Review A*, doi.org/mztc).

We may only see clocks tick because of quantum entanglement

STOCKBYTE/GETTY IMAGES

The researchers then repeated the same calculation, but with the assumption that the magnets and the oscillator are large enough for quantum effects to not alter their behaviour. They thought time could be a consequence of entanglement even for objects that look classical rather than quantum. And they were right.

"If we perceive the passage of time, then there is some entanglement woven into the physical world"

Their equations matched those that physicists have been using to predict the behaviour of classical objects as simple as rolling bowling balls since the 19th century. But still, the variable that ticked to mark each stage of the oscillator's behaviour was a by-product of quantum entanglement.

"They are bridging quantum and classical time," says Basil Altaie at the University of Leeds in the UK. The fact that the researchers studied a concrete and specific system and came up with a variable that matches conventional time may even mean that the only way we should be thinking about time is that it arises from quantumness, says Altaie.

Coppo and his colleagues share this view – entanglement only exists in quantum theory and their work suggests that the existence of time emerges from it. "We believe that nature is genuinely quantum," says Coppo.

This may mean that if we perceive the passage of time, then there is some entanglement woven into the physical world. And an observer in a universe devoid of entanglement – as some hypotheses suggest ours was at its very beginning (see *New Scientist* 1 June, page 13) – would have seen nothing change. Everything would be static.

Now, the biggest question is whether we can test any of these ideas. Vlatko Vedral at the University of Oxford says the idea of time emerging from quantum entanglement is promising, but more details may have to be added to this framework before we can fully understand precisely what time is – and start investigating it experimentally. For one, this research assumes that the two entangled systems don't interact, but that may not always be realistic, he says.

The clock and the other object may even have to interact to become entangled at all. Understanding what happens to the kind of time that emerges from this entanglement when the two objects continue interacting could further prove crucial for formulating new and testable ideas of quantum gravity, says Vedral. ▮

Risk of bird flu outbreak in cows causing a human pandemic is less than feared

Michael Le Page

IT IS looking less likely that the bird flu spreading in dairy cows in the US will spark a pandemic in people. Cow udders – thought to be the main site of infection by the virus – have lots of virus-binding sites similar to those in birds but none resembling those found in humans, a study has shown. This means there is no reason for the virus to evolve inside cows to become better at infecting people.

However, some risk still remains. If farm workers continue to be infected – the US Centers for Disease Control and Prevention announced a third case on 30 May – the virus will still have a chance of evolving to become better at spreading among humans, says study leader Robert de Vries at Utrecht University in the Netherlands.

"For me, it is quite a scary idea to have a virus with these [characteristics] being maintained in a very significant livestock," says de Vries.

For flu viruses to infect cells, they have to bind to a sugar molecule called sialic acid that protrudes from the outside of many cells. However, there are many different variants of sialic acid, and flu viruses can bind only to specific ones.

For instance, the variant found in the upper respiratory tract of birds is different from the one found in the upper respiratory tract of humans. Some other tissues in the human body, such as those in the lungs, do have the so-called bird-like variant, which is why bird flu viruses can sometimes infect people.

Crucially, though, as long as bird flu viruses can't infect the throats and noses of people, they are very unlikely to spread from person to person, because people don't spray these viruses around when they cough or sneeze.

BETTY LARUE/ALAMY

Cattle seem to be more susceptible to bird flu than humans

In the past few years, a particularly nasty strain of H5N1 bird flu has spread all around the world, killing millions of birds. About 60 per cent of people known to have been infected with this virus have died. So far, people have only caught the virus from other animals, but the big fear is that the virus will evolve to bind to the human-like sialic acid, allowing it to spread among people.

This evolution is most likely to happen in a mammal, hence the concern about the H5N1 outbreak in cows.

On 3 May, Richard Webby at St. Jude Children's Research Hospital in Tennessee and his colleagues published preliminary results suggesting that the bird-like sialic acid is abundant in the udders of cows, explaining why H5N1 is able to infect udders.

Alarmingly, these findings suggested that the human-like variant is also common in the udder. This would mean that any H5N1 viruses with mutations that allow them to bind to the human-like variant could survive and thrive in udders, and potentially spread to people.

However, de Vries's team has now done a more detailed study that suggests the human-like receptor isn't present in udders after all (bioRxiv, doi.org/mzs3).

"These viruses keep on doing weird things and surprising us in ways that we'd rather they didn't"

"With the lack of human-type receptors in the mammary gland, where these viruses replicate, the chances of adapting to them are quite slim," says de Vries.

The issue is that identifying the sialic acid variants present in different parts of the body is tricky. Webby's team used only proteins called lectins that bind to specific sialic acids. De Vries's team used the flu proteins that bind to sialic acids – called haemagglutinins – as well as lectins.

"The Dutch team did use a more sophisticated methodology," says Webby. "I much prefer their conclusion."

De Vries and his colleagues also found that neither the bird-like sialic acid nor the human-like one was present in the upper respiratory tract of cows. This adds to the growing evidence that H5N1 is being spread by milking machinery, rather than via respiratory infections, says Thomas Peacock at the Pirbright Institute in the UK.

It also means that cows are unlikely to be infected by human flu viruses, says Peacock, which is more good news.

Virus breeding ground

"One of the worries is that cows could be full of human influenza viruses that we've never really looked for," he says. This would mean a cow might be infected with H5N1 and a human flu virus simultaneously, allowing the viruses to swap genes and potentially generate a new lethal strain capable of causing a human pandemic.

While de Vries's results suggest that cows are unlikely to be a breeding ground for dangerous new viruses, he, Webby and Peacock all say that further studies using a variety of methods will be needed to confirm this.

"Virus evolution is unpredictable and it's hard to say we shouldn't worry about this because these viruses keep on doing weird things and surprising us in ways that we'd rather they didn't," says Peacock.

And eliminating the virus from cows is still important if we are to avoid human infections, which do provide an opportunity for H5N1 to gain the ability to bind to the human-like sialic acid or to swap genes with human flu viruses. ▮

Archaeology

Ancient snake drawings are the largest known rock art in the world

Chen Ly

PREHISTORIC engravings of giant snakes along South America's Orinoco river make up the largest collection of rock art we know of anywhere in the world, with some stretching for more than 40 metres.

The Orinoco is one of the world's largest rivers, flowing through Venezuela and along its border with Colombia. "There's an outstanding record of rock art along the Orinoco, especially on the Venezuelan side," says José Oliver at University College London. "Usually, they are paintings found in rock shelters."

42

The biggest artwork stretches for this many metres

Engravings are common in many open-air sites along the river, he says, but not all of them have been officially recorded.

Since 2015, Oliver and his colleagues have made several trips to areas along the Colombian and Venezuelan margins of the river, with the aim of building a better picture of its rock engravings.

"It wasn't difficult to encounter new sites," says team member Philip Riris at Bournemouth University in the UK. "Every time you go round a corner, there was always more."

Of the 157 rock art sites that the team has managed to visit, 13 were made up of engravings that were at least 4 metres tall. "Anything that size is monumental," says Riris. "That means they're often visible from quite far away, maybe 500 metres to a kilometre."

Most of the engravings depict people, mammals, birds, centipedes, scrolls and geometric shapes, but snakes were among the largest motifs, with the biggest measuring 42 metres across (*Antiquity*, doi.org/mz8p).

In the mythology of the Indigenous Orinoco people, anacondas and boa constrictors are primordial creators, so they are held in high regard, according to Riris.

The prominence of the rock art along the river suggests that the ancient carvings may have been a territorial marker to signal that a certain group lived there, but not necessarily a warning to stay away.

"The engravings may not be exclusionary, but rather an inclusionary practice that was shared among the communities," says Riris.

Ceramics unearthed in the region and dated to 2000 years ago have similar motifs to those of the engravings, suggesting that the rock art was similarly created two millennia ago.

The team hopes to discover even more of these carvings and collect clues about their origins and purpose. For example, many of the artworks appear near rock shelters with burial grounds, which indicates that they may be associated with ancient funerary practices.

"This is a valuable piece of research," says Andrés Troncoso at the University of Chile. "It sheds light about the rock art of a non-well-known area of South America, continuing to fill up our knowledge of this region."

"Euro-American minds often jump to the mammoths, cave lions and large mammals of Pleistocene cave sites in western Europe when they think of rock art," says Patrick Roberts at the Max Planck Institute of Geoanthropology in Jena, Germany. "However, the giant snake engravings studied in the paper are some of the largest single rock art images anywhere in the world and come from the heart of a lowland tropical environment." ▮

JAMES R. BEATTIE ET AL. 2024

Animal etchings on rocks along the Orinoco river in South America

Medical technology

Device laced with living bacteria helps treat skin disease

Jeremy Hsu

A BIOELECTRONIC device that incorporates living skin bacteria reduces inflammation and boosts healthy skin regeneration in mice experiencing psoriasis, a chronic autoimmune disease that is characterised by the accelerated growth of skin cells. A future version of the technology might help treat some of the 125 million people worldwide with the condition.

For a mouse, around a week should be enough for treatment, says Bozhi Tian at the University of Chicago, whose team developed the device. "If you're thinking about the potential clinical application in a human subject, then a longer time will be needed."

The device's top layer has electronic sensors that can measure skin electrical impedance – which is a proxy for tracking skin thickness and dryness – along with body temperature and humidity. The bottom layer consists of a soft hydrogel material that contains living *Staphylococcus epidermidis* bacteria, a component of the normal human skin microbiome. These bacteria are mixed in with starch and gelatine to mimic a "biofilm" in which bacteria can thrive.

The bacteria naturally produce a metabolite capable of disrupting the overactive growth of the skin cells. Over the course of treatment, this metabolite encouraged normal skin growth. The researchers could keep track of the process by monitoring the change in the skin's electrical impedance and observing the reduction in clinical symptoms (*Science*, doi.org/mzrs).

Such technology could eventually lead to devices that use the sensor information to continually adjust the therapeutic benefits of the living bacteria, writes Peder Olofsson at the Karolinska Institute in Sweden, in an accompanying article exploring the implications of the research. ▮

Space

The beauty of chaos

Stunning image reveals the intricate structure of supersonic plasma

Alex Wilkins

JAMES R. BEATTIE ET AL. 2024

THIS is a snapshot from the most detailed simulation yet of the chaotic supersonic plasma that floats across our universe.

Plasmas, or clouds of charged particles, experience turbulence, which dictates key characteristics of our universe, such as how magnetic fields vary over space or how fast stars form. Now, James Beattie at the Australian National University in Canberra and his colleagues have run a simulation of plasma over a 10,000-cube grid at the Leibniz Supercomputing Centre in Germany. The simulation would take 10,000 years to run on an old, single-core computer, says Beattie.

The different colours in this image represent varying charge and gas densities, with red and orange denoting high densities and blue and green revealing low densities. The white lines indicate the contours of the resulting magnetic field lines (arXiv, doi.org/mz3v). ▮

Space

China's moon lander heads back to Earth

THE Chang'e 6 spacecraft has lifted off from the far side of the moon to start its journey back to Earth after a short stay on the surface, according to Chinese state media. It is carrying a cargo of lunar rock, bringing China closer to becoming the first country to return samples from this side of the moon.

It is "an unprecedented feat in human lunar exploration history", Foreign Ministry spokesperson Hua Chunying said on X.

After orbiting the moon for three weeks, Chang'e 6 touched down on 2 June, landing in a comparatively flat region in Apollo crater, which sits within the South Pole-Aitken impact basin.

The far side of the moon has no direct communications link with Earth, so the landing procedure was largely autonomous, although engineers could still monitor the situation and send instructions using the Queqiao-2 relay satellite, which launched in March this year and is currently in lunar orbit.

Once the lander and its attached ascent module had separated from the orbital part of the spacecraft, they began a controlled descent with their engines, using an obstacle avoidance system and camera to detect boulders and select a smooth landing area.

At about 100 metres above the lunar surface, a laser scanner selected a final site before the engines switched off and the vehicle made a cushioned touchdown. The lander then collected samples, using a robotic scoop to gather surface material and a drill to extract rock from about 2 metres underground.

XINHUA/SHUTTERSTOCK

Chang'e 6 on the moon, where it collected rock samples from the surface and from underground

Once the samples were collected, they were transferred to the ascent vehicle. This took off at 7.38am Beijing time on Tuesday and the module containing the lunar material has entered an orbit around the moon.

The craft will make its way back to Earth and is scheduled to release a re-entry capsule containing the samples on 25 June so it can land at the Siziwang Banner site in Inner Mongolia. ▮ **AW**

Analysis Health

Menstruation is occurring ever earlier and we're struggling to work out why

The onset of periods is happening sooner in life for younger generations in the Western world, and there could be multiple factors behind it, says **Grace Wade**

THE age at which menstruation begins has been dropping in Western countries for decades – and a new study indicates that in the US, the trend isn't slowing. What's more, multiple factors are probably contributing to the problem, making it almost impossible to combat.

This is worrying, given that menstruating before the age of 12 is linked to an increased risk of conditions like heart disease and some cancers, says Lauren Houghton at Columbia University in New York, who wasn't involved in the study. For instance, those who begin menstruating between 11 and 12 years old have an almost 10 per cent greater risk of breast cancer, on average, than those who start at 13.

To investigate the onset of menstruation, Zifan Wang at Harvard University and her team collected data via a smartphone app on more than 71,000 people living in the US who had experienced at least one menstrual cycle in their life. On average, participants born between 2000 and 2005 got their first period at 11.9 years old, while those who were born between 1950 and 1969 began menstruation at age 12.5.

"I think it's looking at it too simplistically if we just point the finger at obesity"

The effect was more pronounced in minority groups and those from lower socioeconomic levels. For those born between 2000 and 2005, Black participants got their first period around 11.5 years of age and white participants just after age 12.

So what's behind the trend? Scientists have previously pointed to soaring rates of childhood obesity, because menstruation doesn't occur until a person attains a certain amount of body fat. But Wang and her colleagues estimate that participants' body mass index at the time they got their first period was responsible for only about 46 per cent of the difference in menstruation onset (*JAMA Network Open*, doi.org/mz4m).

"I think it's looking at it too simplistically if we just point the finger at obesity," says Houghton. "The drivers are multi-level and complex."

Stress may also be playing a role. It can increase the levels of certain hormones called androgens, which fat tissue can then convert into oestrogen hormones that drive the onset of menstruation, says Houghton. However, it is unclear if stress levels in adolescents are rising.

Another contributing factor could be chemicals known as endocrine disruptors, which are found in certain plastics, pesticides and other consumer products. These can disrupt, block or mimic naturally occurring hormones, potentially interfering with puberty.

Yet research on how these chemicals affect menstruation has been mixed, and their impact also depends on the age at which people encounter them and the exposure level. For instance, high blood levels of chemicals classified as perfluoroalkyl and polyfluoroalkyl substances (PFAS), otherwise known as forever chemicals, have been associated with delays in menstruation, whereas medium levels are linked to earlier menstruation.

Houghton believes that all of these factors, and some unknown ones, probably interact to lower the age of menstruation. This could explain why it is affecting some groups more. "A lot of these factors are downstream consequences of structural racism and are disproportionately impacting racial and ethnic minorities," says Wang. ▮

Palaeontology

Giant ancient goose weighed as much as a cow

AUSTRALIA'S prehistoric thunder birds – once thought to be the ancestors of emus – were, in fact, the biggest geese that ever lived.

The group has been reclassified following the analysis of a fossilised 45,000-year-old *Genyornis newtoni* skull found near Lake Callabonna in South Australia.

The newly discovered skull is the first from the extinct species found since 1913 and the only one preserved well enough to allow detailed anatomical study. It is thought that *G. newtoni* weighed about 230 kilograms and stood over 2.5 metres tall.

However, its close relative, *Dromornis stirtoni*, reached heights of over 3 metres and weighed up to 600 kilograms, making it by far the largest goose ever as well as a contender for biggest bird too.

ILLUSTRATION BY JACOB C. BLOKLAND

What *Genyornis newtoni* may have looked like, based on fossil evidence

When the first thunder bird fossils were found in the 19th century, they were thought to be the ancestors of the ratites, which include emus and ostriches. Others have since argued that the group should be categorised as land fowl, which includes chickens.

Now, Phoebe McInerney at Flinders University in Adelaide, Australia, and her colleagues have determined that thunder birds were giant waterfowl and should be moved into the same group as geese, the Anseriformes.

The team was mainly convinced by the anatomy of the beak and skull of *G. newtoni*, which is near-identical to that of an old waterfowl lineage, the South American screamers (*Historical Biology*, doi.org/mz45).

All the thunder birds were vegetarians, says McInerney, but they were probably fierce creatures. "They would have been able to defend themselves," she says.

Many thunder bird species died out before the arrival of humans in Australia around 65,000 years ago, but *G. newtoni* and humans overlapped there for tens of thousands of years. ▮

James Woodford

Climate change

Cleaner ship emissions may warm the planet far faster than expected

James Dinneen

A SHARP reduction in sulphur dioxide emissions from ships since 2020 may warm the planet more than expected this decade, although researchers disagree on the magnitude of this change in temperature.

"If our calculation is right, that would suggest this decade will be really warm," says Tianle Yuan at the University of Maryland, Baltimore County. Combined with background warming due to rising greenhouse gas concentrations, the added heat could mean 2023's record-breaking temperatures will be the "norm" in coming years, he says.

Yuan and his colleagues compared the sudden rise in temperature to the "termination shock" that might occur if a solar geoengineering project to curb warming were to suddenly end without a corresponding decline in greenhouse gas emissions.

SUPHANAT KHUMSAP/ALAMY

A 2020 rule put limits on sulphur dioxide pollution in shipping emissions

Ongoing debate

However, other climate researchers say there are issues with the new numbers. "This is a timely study, but it makes very bold statements about temperature changes and geoengineering which seem difficult to justify on the basis of the evidence," says Laura Wilcox at the University of Reading in the UK.

The study adds to an ongoing debate among climate scientists about the consequences of an International Maritime Organization rule that slashed the amount of sulphur dioxide pollution in shipping emissions after 2020. That air pollution from burning heavy marine fuel has been linked to tens of thousands of deaths each year.

However, those aerosols also had a cooling effect on the climate by reflecting solar radiation directly as well as through their brightening influence on clouds over the ocean. Researchers expected that cutting those emissions would result in some warming due to the loss of sulphur dioxide's cooling effects. But the magnitude of anticipated warming ranged widely.

Yuan and his colleagues have now estimated the warming effect of the 2020 rule using satellite observations of cloud conditions, along with mathematical models of how clouds might change in response to the expected reduction in sulphur aerosols.

0.16°C

Increase in average temperatures caused by a 2020 rule change

The team calculates that the drop boosted the amount of solar energy heating the oceans by between 0.1 and 0.3 watts per square metre, about double that of some earlier estimates. This effect was more acute in areas of the ocean with lots of shipping activity: the North Atlantic, which has been anomalously hot since last year, experienced a warming influence more than triple the average, according to the study.

Warming doubled

The researchers then calculated how this warming influence, known as radiative forcing, would change global temperatures, using a simplified climate model that leaves out the influence of the deep ocean. They found that the 2020 change translated to an additional rise of about 0.16°C in global average temperatures in the seven years after emissions dropped, effectively doubling the rate of warming during that period compared with previous decades (*Communications Earth & Environment,* doi.org/gtw2pc).

"This forcing is not a greenhouse gas forcing. It's a shock," says Yuan. "So it's going to be a blip in the temperature record for this decade."

The new numbers are on the high end, but are in line with estimates using other methods, says Michael Diamond at Florida State University. The modelled results match those from a study that directly measured the change in clouds after 2020 in one region of the Atlantic Ocean, for instance.

"There is going to be a blip in the temperature record for this decade"

However, other researchers dispute how the team calculated the resulting change in global temperatures. Zeke Hausfather at Berkeley Earth, a climate think tank, says the team conflated warming influence over the oceans with warming over the entire planet, and that its simplified climate model found a more rapid temperature rise than would occur in reality. "It's really hard to justify more than 0.1°C warming in the near term using modern climate models," says Hausfather.

If the new estimates prove accurate, however, it could help explain some of the huge jump in temperatures seen over the past year. Rising concentrations of greenhouse gases from burning fossil fuels and a shift to El Niño conditions were responsible for most of the heat, but a still unexplained gap has fuelled discussion about whether climate change may be accelerating.

"[The change in shipping emissions] goes some way towards closing the gap that we perceive," says Gavin Schmidt at NASA. But "it's not the whole story". ▮

Analysis Artificial intelligence

Can Google fix its disastrous new AI search tool? For decades it has been the go-to way to find information, but now the leading search engine has told people to eat rocks. What next, asks Matthew Sparkes

GOOGLE is attempting to transform the way we search the internet, but so far it isn't going very well. Rather than simply providing links to other websites, Google's new AI Overviews tool attempts to summarise information, with mixed success – reports of people being told to glue cheese to pizza or dine on rocks have gone viral in the past weeks.

The question now is whether Google can fix this problem it has introduced to its core product, or if it will be forced to roll back the AI tool, which is currently only available to people in the US. Google says it has already made improvements, but experts are divided over whether the generative AI technology powering the tool has fundamental problems that can't be solved.

Noura Al Moubayed at Durham University, UK, says that the large language models (LLMs) used by Google and others will always be flawed when it comes to providing factual information because of their statistical nature: after being trained on vast amounts of text from the internet, they piece together an output based on which word is most likely to fit next. In the case of Google's AI suggesting using glue on pizzas, the origin was traced back to a decade-old Reddit post.

Indeed, Google CEO Sundar Pichai called this an "inherent feature" of such models in a recent interview with *The Verge*, praising the ability of LLMs to be "incredibly creative". But the flip side of that is there is always a risk of plausible-sounding but factually incorrect output.

Al Moubayed believes that technology companies are racing to roll out AI models due to fears of being left behind, urged on by shareholders, meaning products are being launched before they can be depended upon to be accurate. She thinks that solutions could be found, but that they aren't being seriously looked for.

DAVID PAUL MORRIS/BLOOMBERG VIA GETTY IMAGES

Google CEO Sundar Pichai says AI models can be "incredibly creative"

"Google is less focused on the accuracy of search and more focused on the glitter of the AI"

THILINA KALUTHOTAGE/NURPHOTO VIA GETTY IMAGES

"It is potentially fixable, long term, but seeing how much interest big companies are actually paying into fixing the language models rather than making money out of the language models, this will probably take a really long time," she says. "I'm not really against the idea [of AI search]. But it has to happen gradually and in a transparent way, because of the impact that will have on the world. The lack of transparency is quite alarming."

Al Moubayed believes that governments need to intervene to stop companies releasing these models before they can be proven to be accurate and reliable. But despite repeated pledges – such as at the UK's AI Safety Summit last year – she doesn't think these have yet shown concrete results.

Eric Atwell at the University of Leeds, UK, is confident that technology companies will, in time, overcome the tendency of LLMs to make things up. One possible solution is a technique called retrieval-augmented generation (RAG), says Atwell, where the AI is instructed only to pull factual information from a small and highly reliable source of data, such as the lecture notes from a particular university course – and to not fabricate responses to questions if the answer isn't in that data.

"I think there's a tendency to focus on a few counter examples rather than the vast majority of cases where it's doing fine," says Atwell. "It's just, unfortunately, occasionally it doesn't work out correctly. Technology is moving so fast – why would you want to slow it down just because there's a few bugs in it?"

RAG-based search engines already exist, says Philip Feldman at the University of Maryland, Baltimore County. For example, perplexity.ai makes things up less frequently in his experience, and also shows citations for any factual information. Feldman believes that Google could build a similar model, but that it is under pressure to instead create an AI that generates compelling and conversational text.

"They are less focused on the accuracy of search and more focused on the glitter of the model, the impressiveness of it. It's sort of a philosophical difference between extracting value and providing value. Yes, you can get a lot more money in the short term if you extract, but, in the end, you're going to poison the well," he says.

Yet even RAG isn't a full solution, says Feldman. While it can reduce the frequency of inaccuracies, it can't fully eliminate them. Paradoxically, a small chance of errors can increase the damage they cause, as most people won't bother to check the accuracy of a tool that is extremely reliable. The ultimate solution may be another layer of RAG-like systems to keep the first in check, says Feldman, and perhaps yet more layers will be needed to catch increasingly infrequent errors at each level.

Google didn't respond to a request for comment. ▮

Language

Babies squeal and growl with purpose as a way to prepare for speaking

Christa Lesté-Lasserre

BABBLING "dada" or "mama" is thought to help babies learn how to talk, but even the growls and squeals that pre-empt these noises could be setting them up for speech.

Starting in the first month of life, babies appear to create these seemingly simple sounds in clusters, not sporadically, which suggests they are "practising" vocal communication before learning to talk.

"Our findings reveal that infants engage in practice with various vocal types from the earliest months of life… laying a foundation for further language development," says HyunJoo Yoo at the University of Alabama in Tuscaloosa.

Previous studies have investigated the babbling that babies make between around 5 and 7 months of age, says Yoo. However, the three most common kinds of more basic infant vocalisations – squeals, growls and medium-pitch, vowel-like noises called vocants – have rarely been looked into.

To learn more, Yoo and her colleagues asked the parents of 130 babies – 71 boys and 59 girls, who all appeared to be developing as normal and lived in or around Atlanta, Georgia – to place small voice recorders in the pockets of the infants' clothing for 16 hours per day, once a month for the first two years after birth.

The researchers randomly selected 21 segments of 5 minutes in duration from each day of the recordings of each baby. They then categorised each of the sounds the babies made as either squeals, growls, vocants or other noises, such as blowing raspberries or whimpering.

The team found that all the babies showed a clustering together of squeals, growls or both. This means they happened more often than by mere chance over the 5-minute periods and therefore weren't just random noises, but perhaps a form of preparation for eventually speaking, says Yoo.

"Our findings reveal that infants engage in practice with vocal types from the earliest months of life"

Overall, 40 per cent of the squeals and growls occurred in clusters. In 61 per cent of the recordings, the clusters were made up of either squeals or growls, not both (*PLoS One*, doi.org/mznh).

For 87 per cent of the babies, the preference for either squeal or growl clustering was related to their age, with squeals in particular being more common in those who were at least 5 months old. That might be because squeals are high pitched and therefore require more advanced control over the vocal cords, but this finding requires further investigation, says Yoo.

The researchers also found that the babies clustered vocants, but their analysis didn't focus on these.

It was a surprise to discover that even the youngest babies created sound clusters, says Yoo. This contrasts with previous research that suggests infants start "playing" with vocalisations at around 3 to 4 months old, but more research is needed to back up the latest findings, she says.

"We are not inclined to view this pattern of age results as offering the final word about vocal category clustering." ▮

Genetics

Fern has a genome 50 times larger than that of humans

A PRINTED version of the human genome would fill 220 large books. That of a small fern found on a few Pacific islands would require nearly 11,000 books.

Jaume Pellicer at the Botanical Institute of Barcelona in Spain and his colleagues have discovered that the plant, called *Tmesipteris oblanceolata*, has the largest known genome of any organism.

Growing only on some islands of New Caledonia and Vanuatu in the south-west Pacific, each of the fern's cells has 321 billion letters – or base pairs – of DNA in its nucleus (*iScience*, doi.org/gtw6d6). If arranged in a line, this would stretch for around 105 metres.

ORIANE HIDALGO

The plant *Tmesipteris oblanceolata* has spore-producing structures

The nucleus of a human cell contains just over 6 billion base pairs, around 2 metres, of DNA – about 50 times less than the fern.

To work out the size of the plant's genome, the team extracted the nuclei of cells from its stems, stained the DNA inside the nuclei with a fluorescent dye and then measured the light intensity as the nuclei passed under a light detector.

As to why it has such a massive genome, the key factor is probably a failure to control the growth of so-called transposons. These are bits of DNA that can copy and paste themselves, causing genomes to expand rapidly unless organisms evolve ways to suppress them or manage to get rid of the excess DNA.

Having a massive genome is a disadvantage, says Pellicer. "Every time a cell has to divide, it has to replicate all the DNA," he says. "So the more DNA there is, the longer it takes to be replicated."

Plants that fail to control transposons tend to go extinct, he says. *T. oblanceolata* may survive only because competition is less intense on small islands, he says.

"It is exciting to see that we are still finding new boundaries on how large nuclear DNA contents can get," says Ryan Gregory at the University of Guelph in Canada. ▮

Michael Le Page

Conservation

Snaring crisis has no easy fixes

The widespread use of animal traps in South-East Asia is a major threat to wildlife, but snare removal programmes can only do so much, reports **James Woodford**

AT ANY time, there are estimated to be at least 13 million snares in protected areas of Laos, Cambodia and Vietnam that have been set by local hunters, seeking wild meat. These simple devices indiscriminately kill large numbers of threatened animals, including tigers, elephants and monkeys.

Between 2011 and 2021, snare removal teams confiscated 118,151 snares from two reserves in Vietnam. While this approach has helped save many animals, it can't address the huge scale of the problem across South-East Asia. Researchers say more must be done to reduce the demand for wild meat – but there are no easy solutions.

"As long as the demand is there and prices remain high for wild meat, then local people will snare"

The vast majority of the snares are professionally made, wire noose traps, says Andreas Wilting at the Leibniz Institute for Zoo and Wildlife Research in Berlin, Germany. Brush fences are often placed between the snares, so animals are driven into the traps, he says.

Wilting and his colleagues, who also included staff of conservation group WWF Viet Nam, examined the impact of 11 years of determined snare removal in two protected areas in central Vietnam: Hue Saola Nature Reserve and Quang Nam Saola Nature Reserve. Together, the areas cover nearly 32,000 hectares (79,000 acres) of closed canopy rainforest.

They are especially important for protecting numerous endangered and endemic species found in the Annamite mountain range, including a large bovine called the saola (*Pseudoryx nghetinhensis*), which was only described in 1993 and hasn't been seen in the wild since 2013. Although hunting is illegal in both reserves, it is still commonplace, say the scientists.

Andrew Tilker, a team member at the Leibniz Institute for Zoo and Wildlife Research, says most snaring in South-East Asia is done for restaurants and wildlife markets, rather than being subsistence-based.

The researchers divided the protected areas into 200-square-metre cells and then assessed whether the effort to continually remove snares and fences led to any decrease in hunting.

The "forest guardians" paid to remove the snares often spent up to a week at a time trekking and camping in the rainforests, says Luong Viet Hung, from WWF Viet Nam. He says 20 to 30 per cent of those hired to remove snares were once poachers themselves.

Over the 11 years, the researchers estimate there was a 36.9 per cent reduction in the number of cells in which snares were found. The average area the forest guardians had to cover to find each snare increased from 1.3 hectares in 2011 to 2.6 hectares in 2021 (*Society for Conservation Biology*, DOI: 10.1111/conl.13021).

ANDREW WALMSLEY/NATUREPL.COM

A snare collected by a ranger in Sumatra, Indonesia

The programme cost about $220,000 per year – which came from WWF Viet Nam and the Vietnamese government – meaning the average cost of removing each snare was $20.50. In comparison, the cost of setting each snare was about $1.13.

Although the programme was successful, this approach can't address the threat of wildlife snaring on its own, the team says. In fact, it may have simply driven poachers deeper into the forest or into other reserves, it says.

The researchers estimate that rolling out such snare removal efforts across the whole of South-East Asia would cost hundreds of millions of dollars, and may be impractical. To prevent the extinction of many of the region's iconic large animals, governments and other organisations must work with local communities to address the underlying drivers behind snaring, according to the team and other experts.

AFRIANTO SILALAHI/NURPHOTO VIA GETTY IMAGES

A Sumatran tiger that died after getting caught in a snare

Final nail in the coffin

"While there is a whole laundry list of threats facing wildlife in protected areas, snaring may be the final nail in the coffin for many species on the brink of extinction in South-East Asia and beyond," says Christopher O'Bryan at Maastricht University in the Netherlands. He says snare removal is one tool to address the issue, but it should also be used alongside long-term strategies that tackle the socioeconomic reasons for snaring.

Jan Kamler at the University of Oxford is downbeat about the issue and says snare removal won't solve the problem. He says indiscriminate snaring has already eliminated tigers and leopards from Cambodia, Laos and Vietnam.

"Probably the only solution is to affect the demand side, which likely will take a generation even if a concerted effort is made," says Kamler. "As long as the demand is there and prices remain high for wild meat, then local people will snare even if alternative livelihoods are available." ▮

Astronomy

‘Unlucky’ star may be trapped in dance with black hole

Alex Wilkins

A STAR appears to be locked in a lethal dance with a supermassive black hole. According to a team of astronomers, this unlucky star gets almost torn apart each time its orbit swings past the black hole.

If a star gets close enough to a supermassive black hole, it can be tidally disrupted, which means the black hole’s gravitational field stretches the star and siphons off material, producing a burst of radiation that can be observed from Earth. Stars are often destroyed in the process, but they can also survive in what are called partial tidal disruption events.

Zheyu Lin at the University of Science and Technology of China in Hefei and his colleagues say they have spotted a star that has undergone two partial disruptions, around 710 days apart. The team first spotted a flare in 2022, in a galaxy around 400 million light years from Earth. In January, the researchers observed a second flare from the same galaxy.

After comparing the spectroscopic pattern of light from the two flares, they concluded that they appeared to have come from the same star. “With the spectroscopy, we see some special fingerprints in this event,” says Lin. In a paper reporting their findings, they call it “the unluckiest star” (arXiv, doi.org/mzns).

Despite the similarities between the two observations, more evidence is required to say they come from the same star, says Andrew Norton at the Open University in the UK. “Claiming something is periodic on the basis of two observations is stretching things.”

Lin and his team hope to observe the star being disrupted a third time in another two years, which would make the situation clearer – but it is also possible that it was destroyed during the second flare. ▮

Health

Tetanus vaccine might protect against Parkinson’s disease

Clare Wilson

FG TRADE/GETTY IMAGES

Parkinson’s affects movement, often causing tremors

THE exact cause of Parkinson’s disease is unknown, but it has long been suspected to be a combination of genetic and environmental factors. Now, a radical new idea suggests the condition could be triggered by the bacteria behind tetanus.

This stems from the finding that people who have recently been vaccinated against tetanus to prevent a wound infection are half as likely to later be diagnosed with Parkinson’s. “The closer to the vaccine date, the less likely individuals are to get diagnosed with Parkinson’s disease,” says Ariel Israel at Tel Aviv University in Israel.

Widely available tetanus vaccines could therefore prevent or treat Parkinson’s. If confirmed in further studies, “it’s big news”, says Israel. “I really hope that it will change the way we understand and treat the disease.”

The researchers analysed the records of a large health provider in Israel to see if any vaccines given in adulthood were linked with an altered risk of Parkinson’s. They picked nearly 1500 people who had been diagnosed at 45 to 75 years old, then compared them with a five-fold larger control group who had similar characteristics to those with the condition.

They found that 1.6 per cent of people with Parkinson’s had a record of having the tetanus vaccine before their diagnosis, compared with 3.2 per cent of those without the condition (medRxiv, doi.org/mznm). The protective effect was bigger in those who had the vaccine more recently, with no one developing Parkinson’s within two years of being immunised.

2x

Greater risk of Parkinson’s without a tetanus vaccine

In many countries, adults generally get a tetanus vaccine if they have a wound contaminated with soil, faeces or saliva, as the bacterium that causes the condition, *Clostridium tetani*, can be found in these substances. If this infects a wound, it can lead to spasms and even death.

C. tetani is known to release a toxin that damages nerve cells; it is the effects of this toxin that cause the characteristic spasms after a tetanus wound infection.

The tetanus vaccine is an altered version of this toxin, which causes the immune system to make antibodies against the real molecule.

C. tetani can live harmlessly in the gut, and Israel speculates Parkinson’s may arise if it transfers to the nose and then travels up to the brain.

“We know that this toxin can travel along the neurons,” he says. “I do not think that the mere presence of *Clostridium tetani* somewhere in the microbiome is sufficient to cause the disease. There are probably some other factors, like genetic factors, that cause some people to be particularly sensitive to the damage caused by the toxin.”

Roger Barker at the University of Cambridge says the analysis considered quite small numbers of people when comparing those who had their vaccine at different intervals before they developed Parkinson’s. “But I think it’s interesting and worth looking at in other populations.”

Claire Bale at the charity Parkinson’s UK says it raises “the interesting possibility that tetanus vaccinations could have the potential to offer protection against the development of Parkinson’s and may even be able to slow progression of the condition. As this is something current treatments can’t do, this would be hugely significant if realised.” ▮

Artificial intelligence

AIs join computer bug hunt

Tools similar to ChatGPT are able to identify errors in computer code, letting people claim rewards for finding them – but there are downsides, reports **Alex Wilkins**

ETHICAL hackers are using artificial intelligence tools to find bugs in computer code and claim rewards worth thousands of dollars. However, others are using the same AI tools to generate realistic but nonsensical bug reports, making it hard to know which reports to trust.

Bug bounty schemes offer financial rewards for people who can find flaws in software. These schemes have been used in cybersecurity for decades to encourage people to report problems so programmers can shore up security, both in established tech companies, like Microsoft or Google, and for freely available software.

Yang Liu at Nanyang Technological University in Singapore and his colleagues have developed several tools that use large language models (LLMs) like GPT-4, the technology that powers ChatGPT, to find and fix security flaws in smart contracts, which are digital agreements stored on blockchains, such as the Ethereum network.

These contracts relate to things like house purchases or agreements on how crowdfunding campaigns should spend raised funds, and are automatically carried out according to set rules and conditions written in code. If there are errors or loopholes in this code, hackers can exploit them to take the money detailed in the agreement.

One tool that Liu and his team developed, called GPTScan, found nine vulnerabilities in smart contracts that people had missed. Another tool, called PropertyGPT, can generate smart contract code according to written specifications, as well as check the contracts for errors. When Liu and his colleagues used PropertyGPT to check existing smart contracts on the platform Certora, they found 12 bugs that they submitted to a bounty programme to claim a reward of $8256.

12

Bugs on smart contract platform Certora found using AI

$8256

Reward claimed from Certora for finding those bugs

"I have seen an increase in reports that initially look like genuine security flaws but are actually nonsense"

Liu and his team are now working on building a more advanced bug-checking tool. "Our general methods are not only applicable to smart contracts, but actually we can use them to find vulnerabilities in other programming languages," says Liu.

They aren't the only ones working on uncovering bugs. Other ethical hackers have also started integrating publicly available AIs into their toolkits, says Dane Sherrets at HackerOne, a cybersecurity company that helps software companies run bug bounty schemes.

Sherrets, who also looks for bugs in his spare time, says he has seen hackers using customised tools built by modifying OpenAI's ChatGPT. These AIs can both scan for vulnerabilities in chunks of code and help with testing a system's cyber defences, such as generating lists of words to send to a system that might reveal a security flaw.

They are also useful to help write and communicate the bugs' severity and impact to developers, says Sherrets, which can be a hard task for programmers who are immersed in the technical details but may struggle with producing written reports. "I think that's going to be tremendously helpful," he says.

However, the convincing language generated by LLMs can also present problems. Daniel Stenberg, who created and helps manage cURL, a tool used by thousands of programmers to fetch data from web addresses, has seen an increase in reports that initially look like genuine security flaws but are actually nonsense, seemingly generated by AI.

"I have not seen one [AI-generated report] yet that actually identified a real problem," says Stenberg. "They're all hallucinations, more or less."

The reports take time to look through and aren't easy to identify as being generated by an AI at first glance, he says. "It's not just a simple, single line where the human is saying something is wrong here," he says. "No, you'll get 200 lines, including different screenshots and everything from the AI."

The better the AI reports get, while still being wrong, the more work they end up creating, says Stenberg. "I'm a little bit scared about it."

Sherrets agrees that this could be a nuisance, although he says a way around this could be to have publicly rated profiles of hackers who submit reports on platforms like HackerOne, which would discourage people from submitting bogus reports. "I'm pretty optimistic that the industry at large will have really good ways of finding additional vulnerabilities and directing people somewhere they can submit them," he says.

AI can help find bugs in computer code that might be exploited by hackers

SEAN ANTHONY EDDY/GETTY IMAGES

Archaeology

Ancient Egyptian skull shows oldest known attempt at treating cancer

Chen Ly

TINY etchings on a 4000-year-old skull suggest that the ancient Egyptians may have been the first people to try to treat cancer.

"Ancient Egyptian medicine was very advanced," says Edgard Camarós at the University of Santiago de Compostela in Spain. "They were able to deal with many conditions, including traumatisms and infections, and treat oral health."

Camarós and his colleagues studied two skulls held at the University of Cambridge's Duckworth Laboratory collection. One skull belonged to a woman who was at least 50 years old and lived in Egypt between 663 and 343 BC. The other is dated to between 2687 and 2345 BC and belonged to a man aged 30 to 35 years old.

When the researchers viewed the specimens under a microscope, they saw that both skulls had big lesions that suggested the presence of cancerous tumours that degraded the bone.

TONDINI, ISIDRO, CAMARÓS, 2024

The skull of an ancient woman who probably had bone cancer

The woman probably had a type of bone cancer called osteosarcoma, says Camarós, and also had a couple of healed lesions that seem to be from traumatic injuries. These signs suggest that the ancient Egyptians may have been quite adept at treating traumatic or violent wounds.

The man probably had nasopharyngeal cancer, says Camarós, which begins in the tissues of the top of the throat. Around 30 smaller lesions around the skull indicate that the cancer had metastasised (*Frontiers in Medicine*, doi.org/mzhm).

"We were looking at the bones with the microscope and suddenly some cut marks appear in relation to those tumours," says Camarós. These small incisions around the lesions hint that Egyptian doctors at the time tried to treat the cancer surgically or may have conducted exploratory operations after the person had died.

Although the man seems to have died due to cancer, this is the earliest known evidence of an attempt to treat it, says Camarós. "It is a milestone in the history of medicine."

"They didn't have a word for cancer, but they did for swelling and tumour," says Camarós. "But the root of how we successfully treat cancer nowadays is there, 4000 years ago."

"It is likely that the therapeutic approach targeted the signs and symptoms associated with visible external lesions, without necessarily recognising its underlying disease," says Carina Marques at the University of Texas at Rio Grande Valley. "The modern concept of cancer emerged only in a very recent period of our history. It is unlikely that an ancient Egyptian recognised cancers from other diseases with similar presentation." ▮

"They didn't have a word for cancer, but the root of how we treat it nowadays is there, 4000 years ago"

Psychology

Baby chicks link sounds and shapes just like we do

TO HUMANS, some words seem to fit better with sharp shapes than round ones – and the same appears to be true for baby chicks.

Research has shown that people tend to associate the nonsense word "bouba" with round shapes and "kiki" with spiky shapes. Many studies have found that the phenomenon is near-universal, applying in people across ages, cultures and languages.

"The effect is one example of sound symbolism, this spontaneous association between sounds and shapes," says Maria Loconsole at the University of Padua in Italy. "It's the building block of language in humans."

To explore whether this effect is learned through experience or whether it is a more innate characteristic of animals, Loconsole and her colleagues decided to put newborn chicks to the test.

Baby chicks were an obvious choice of subject, says Loconsole, as they are born with fully developed motor, visual and nervous systems.

To begin with, the team took 42 3-day-old domestic chickens (*Gallus gallus*) one by one into a small arena with two panels: one blank and one featuring an ambiguous shape with both spiky and round edges. Behind the panel with the shape was a mealworm.

After roughly 10 minutes of familiarisation with the set-up, the team swapped out the panels for one with a completely round shape and one with a completely spiky shape. But this time there was no mealworm reward.

OLEKSANDR LYPA/ALAMY

Chicks can explore their environment as soon as they hatch

An audio recording of someone saying either bouba or kiki was then played while the chicks could freely move around the arena. Each chick underwent 24 trials, with the team switching up the order of panels and which word was played every time.

Overall, the chicks were much more likely to approach the round shape when they heard "bouba" and the spiky shape when they heard "kiki" (bioRxiv, doi.org/mzn4).

Being able to link certain sounds with specific symbols or shapes can help animals explore and even make some predictions about the world, says Loconsole. For example, they might associate the sound of a predator with their shape and know to stay away.

"It suggests that the bouba-kiki effect in humans is probably not driven by speech or language but rather by automatic associations between shapes and sounds that we experience in the world," says SP Arun at the Indian Institute of Science. ▮

Chen Ly

Survey

NewScientist

Tell us what you think

We are always looking for ways to better get to know our customers. By completing this survey, you will help us understand your experience of *New Scientist* and find ways to improve what we do. As a thank you for taking part, you have the option to enter a prize draw to win one of three £100 Amazon gift cards.

Complete the survey at newscientist.com/survey1

The survey prize draw is open to UK residents (excluding Northern Ireland) only and will close on 21 June 2024 at 11:59pm BST or after 10,000 people have completed the survey, whichever happens first. Only one entry per person will be accepted into the prize draw. Three winners will be drawn at random from the submitted surveys and will receive 1x£100 Amazon gift card each; prizes are as described, there is no cash alternative. For full terms and conditions see newscientist.com/terms-and-conditions-for-free-prize-draw/

Views

The columnist
Graham Lawton on the benefits of wood in construction p24

Aperture
An unusual look at a deep-sea anglerfish p26

Culture
An impressive book dissects consciousness p28

Culture columnist
Emily Wilson reads a posthumous book by Michael Crichton p30

Letters
Ageism is alive and well in many walks of life p31

Comment

Racial trauma

Race is a social construct, but racism can cause real harm to both the body and the mind, says **Layal Liverpool**

IT HAS been more than four years since Darnella Frazier, then a teenager, captured on camera the murder of George Floyd, an unarmed Black man, by white police officer Derek Chauvin in Minneapolis, Minnesota. Yet the impact on Frazier's brain of what she witnessed could linger for much longer.

"I still hold the weight and trauma of what I witnessed," Frazier wrote in a social media post on the one-year anniversary of Floyd's murder. "I'm not who I used to be. A part of my childhood was taken from me."

Burgeoning evidence suggests racism causes stress and trauma that can take a serious toll on both body and mind. Even simply watching a video like the one Frazier recorded can be traumatic, let alone witnessing it and recording it for the world to see.

SIMONE ROTELLA

A survey of 134 college students in the US, who were mainly Black or of Latin American ancestry, published in the weeks after Floyd's murder, found they reported experiencing symptoms consistent with post-traumatic stress disorder after viewing videos on social media showing Black men being killed at the hands of police. In addition, a 2018 review that examined the scientific literature on racial discrimination and trauma found a positive association between the two and called for more research on the topic.

Separate research points towards a potential association between past traumatic experiences and dementia risk in later life. A 2017 study found a link between childhood trauma and late-life dementia among Aboriginal and Torres Strait Islander peoples, who experience a rate of dementia three to five times greater than Australia's wider population.

The study notes that participants' scores in a childhood trauma questionnaire were associated with several indicators, including separation from family "by a mission, the government or welfare". This refers to a series of racist assimilation policies implemented by the Australian government between 1910 and the 1970s, under which many Aboriginal and Torres Strait Islander children were forcibly removed from their families.

Racial disparities in the incidence of dementia are also present in the US, where the prevalence of Alzheimer's-related dementia is greater among Black people compared with white people. In 2019, a study found early signs that this might be related to racial discrimination. Researchers surveyed 71 African American research participants about their experiences of racism. The team later scanned the brains of these people using magnetic resonance imaging (MRI) to measure their white matter lesion volume – an early biological marker of cognitive decline. This found that among older African Americans, self-reported lifetime discrimination burden was associated with greater white matter lesion volume.

Measuring the effects of racism on the brain is challenging, but these findings – and experiences like Frazier's – suggest it is worthwhile. In particular, understanding how racism might contribute to dementia risk will be important in a world where the number of people living with the condition is expected to rise from more than 55 million in 2020 to 78 million by 2030.

Governments – and all of us – should pay attention. Beyond dementia, high levels of perceived discrimination among racial and ethnic minority groups have been associated with an increased risk of a broad range of health conditions, from cardiovascular disease to breast cancer to mental health conditions.

Race is a social construct, but that isn't a reason to dismiss the biological consequences of racism. The science tells us we should take them seriously. ▮

Layal Liverpool is a journalist and the author of *Systemic: How racism is making us ill*

No planet B

Turn to the trees The burgeoning use of wood as a building material is a path to more sustainable construction, and it may have psychological benefits too, writes **Graham Lawton**

Graham Lawton is a staff writer at *New Scientist* and author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

Graham's week

What I'm reading
You Don't Have to Be Mad to Work Here: A psychiatrist's life *by Benji Waterhouse.*

What I'm watching
The final season of Inside No. 9 *on the BBC.*

What I'm working on
An amazing story about dementia.

New Scientist video
Watch video of Graham's visit to the two wooden building projects at youtube.com/newscientist

This column appears monthly

A FEW years ago, I wrote an article about new uses of wood, including as a sustainable construction material. It was a surprise hit. Since then, we have covered wood technology as often as possible.

So when I was invited to Paris to visit two state-of-the-art wooden building projects, I jumped at the opportunity. One is a refurb, the other brand new, but both are built almost completely from wood and have enviable environmental credentials, as well as being aesthetically stunning. I have sung the praises of wooden buildings for years, but had never been inside one. Now I have, I am smitten.

My first port of call was a city centre development called Marcadet Belvédère, a former parcel terminus for the French railway network overlooked by the Basilica of the Sacred Heart. A long-abandoned eyesore, the developer WO2 is adding five extra storeys to the concrete shell to create office space. The new storeys are mostly made of cross-laminated timber (CLT), an engineered wood product that rivals concrete and steel as a structural material, but with a much lower carbon footprint.

According to WO2's director of engineering, Laurent Petit, the wood the firm uses – sourced from Stora Enso in Austria – brings significant environmental benefits. Over 50 years, Marcadet's total emissions will be half of what a traditional concrete and steel refurb would have belched out. That is largely due to the materials, but also reduced running costs.

"When we started to build in wood, the purpose was to reduce the carbon footprint, but then we discovered a lot of other benefits," Petit told me. CLT is 80 per cent lighter than the combined mass of concrete and steel, so there is no need to reinforce foundations at financial and environmental cost. It is quicker to build with, requires fewer trucks and less heavy equipment to be brought on site, and has useful thermal properties.

A standard building has high "thermal inertia", meaning it takes a lot of time and energy to warm up and cool down. But in a CLT building, the moment you start the heating, you start to feel the warmth in the atmosphere, says Petit. Cooling is less straightforward, but at Marcadet, this is aided by the plants and trees in the building's rooftop garden. When it is hot, these evapotranspirate water from the soil and hence draw out heat from the rooms below.

"Contact with nature, even via the built environment, has physiological and psychological benefits"

There are wider thermal benefits too. During a heatwave, concrete soaks up heat and radiates it out at night, keeping the city sweltering. Wooden buildings don't do this. Deadly heatwaves are a growing problem in Europe and are especially dangerous when there is no respite at night.

Wooden buildings can burn, of course, but Marcadet shouldn't. "What burns in a building is the furniture, not the structure," says Petit. "Yes, wood burns, but ignition is slow and almost never happens." Marcadet is further protected by a sprinkler system pioneered in art galleries that sprays minuscule droplets of water. These don't quench the flames directly, but cool the fire down. The droplets instantly evaporate and the latent heat of this process helps put out the fire.

Next, I visited another WO2 project. Arboretum, on the western fringes of Paris, is a stone's throw from the skyscraper jungle of the La Défense business district, but a million miles away in spirit. "It's the largest wooden office project in Europe," says Laurence Desmazières at investment fund ICAWOOD, one of the project's backers. Arboretum is a campus comprising five new low-rise offices set in parkland. The buildings are made largely of CLT, which, as at Marcadet, means the project has half the lifetime carbon emissions of a standard new build.

Inside the buildings, the wood is deliberately and beautifully exposed on walls, ceilings and columns. "You can feel the wood, touch the wood, see the wood, smell the wood," says Desmazières. "Wood also has very good acoustics. The idea is to offer nature to people inside the buildings."

It isn't just aesthetically pleasing. Contact with nature, even via the built environment, has proven health benefits. "Being in a wood environment helps from a physiological and psychological standpoint," says Desmazières. "You're less stressed and you sleep better."

I would certainly swap my office space for a desk surrounded by gorgeous wood. In France, that will increasingly be on offer. Recent laws demand that developers calculate the lifetime carbon footprint of any new building. Those that exceed a certain threshold won't be given planning permission. That is sending firms scurrying to source greener materials such as CLT, says Desmazières. "Wood has great days ahead." ▮

THE WORLD'S GREATEST FESTIVAL OF IDEAS AND DISCOVERIES

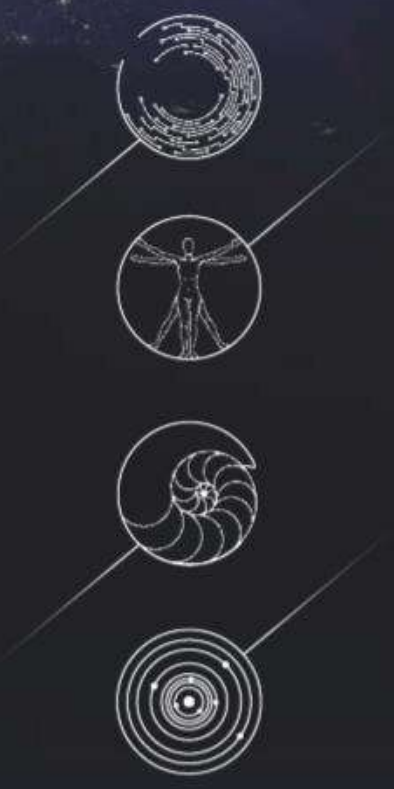
12–13 OCTOBER 2024 | SCHOOLS' DAY 14 OCTOBER

EXCEL LONDON AND ONLINE

New Scientist Live

HURRY
SUPER EARLY BIRD DISCOUNT FOR SATURDAY TICKETS ENDS 9 JUNE

SATURDAY TALKS INCLUDE:



THE FUTURE STAGE

Discover the world of tomorrow and explore the innovations that will power the technology of the next decades

Anomalistic psychology
AI needs you | A life of crime?
Your part in the climate change challenge

OUR PLANET STAGE

Your home for all things environmental

A talk on the wild side
Saving the world's largest flowers
Volcanoes and past climate | Infinite life
The science behind the UK's pooches

MIND AND BODY STAGE

All about being human and amazing research to help you live a healthier life

How to eat for better brain health
Genetic genealogy meets history and forensics
Why we die | Evolution of free will
Where are you really from?

THE UNIVERSE STAGE

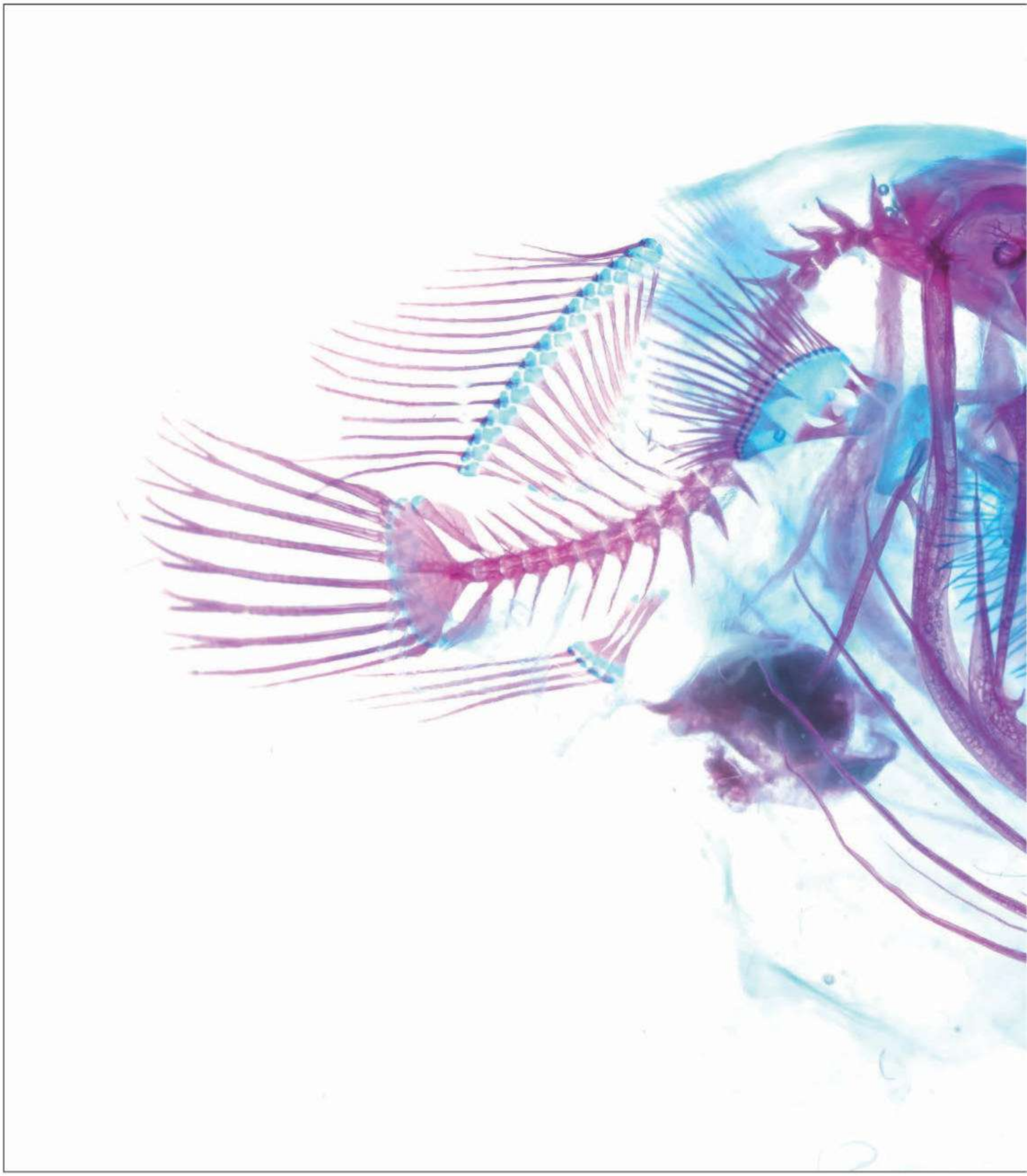
The place to hear about the mysteries of the cosmos

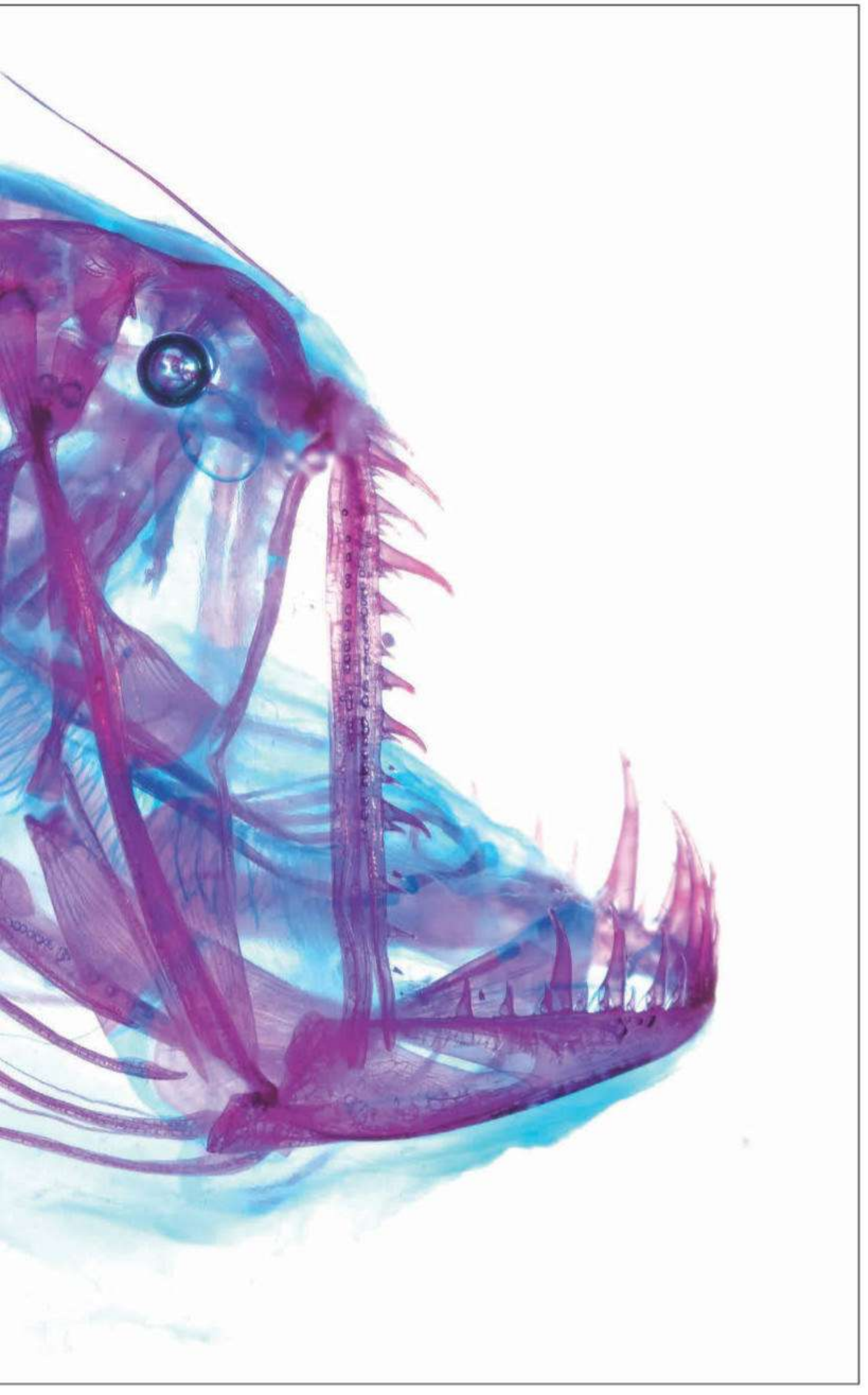
CHARGE: why does gravity rule?
Bejeweled island Universes
Our accidental Universe

FIND OUT MORE AT

NEWSCIENTIST.COM/NSL2024

FEATURE PARTNERS | LEARNING PARTNER | SCHOOLS' DAY PARTNER | CHARITY PARTNER | WIDENING PARTICIPATION PARTNER | MEDIA PARTNER





Devilishly scary

Photographer **Solvin Zankl**
Agency **Nature Picture Library**

WITH its gaping jaws and pointy teeth, this humpback anglerfish (*Melanocetus johnsonii*) seems even more terrifying when its inner intricacies are revealed. The deep-sea monster, also known as Johnson's abyssal seadevil, was photographed by Solvin Zankl.

The image shows the fish after a long process of cleaning and staining to reveal its internal structures. Scientists used a digestive enzyme to remove the soft tissue, exposing bones and collagen, which were then stained. Blue shows cartilage, while the red is bone. Sometimes not all tissues become transparent during the chemical processes: for example, the dark mass (left) is the fish's stomach.

This technique offers a rare glimpse inside the anglerfish, from its gills to its two sets of impressively scary jaws – just one of the remarkable adaptations that have evolved in deep-sea species, says Zankl. But don't worry: females, like the one shown here, grow to about 153 millimetres long, while males are a mere 28 millimetres.

The fish live at a depth of about 900 metres in tropical oceans. This specimen was collected from the Benguela Upwelling System, very fertile deep waters in the South Atlantic Ocean, off the coast of South Africa and Namibia, during a research expedition to document the region's wildlife.

Since deep-sea photography is a big challenge, Zankl says that working with scientists lets him visit otherwise inaccessible places. Documenting such creatures sheds light on their biology and on the broader ecological processes in fragile ecosystems, he says.

Gege Li

Are you conscious?

An impressive book challenges the idea at the heart of much AI research – that simulating consciousness is identical to the real deal, says **Jonathan R. Goodman**

Book

Then I Am Myself the World

Christof Koch

Hachette UK; Basic Books (US)

A FEW weeks ago, during a journey on the Eurostar, I started reading a new book about consciousness. I had barely begun when the man sitting opposite asked about it. He told me – a consequence perhaps of the unique way that train travel can create short yet oddly close friendships – that, after a near-death experience, he became interested in the mind.

He asked if I knew what consciousness was, and I said I had no idea – quoting instead a line I had heard early in my studies of philosophy about "awareness of awareness". I added, embarrassed by his recognition of this formulation, that I hoped to find out and would report back.

I am happy to say that after reading *Then I Am Myself the World: What consciousness is and how to expand it* by neuroscientist Christof Koch, I feel somewhat closer to the first of these aims.

Koch, with his wide-ranging knowledge of neuroscience, physics, computer science and psychology, explains his view of what consciousness is, relying on metaphors that elucidate complex ideas such as computational functionalism and one of the leading hypotheses about consciousness, integrated information theory (IIT). In fact, the two form the opposition that creates a foundation for the book.

Functionalism, championed by many of the wealthy and powerful who make up Silicon Valley and those who research artificial intelligence, sees consciousness only in terms of outputs. That idea is at the heart of another leading hypothesis, global neuronal workspace theory, says Koch. If AI successfully imitates a conscious being by the way it responds to questions (inputs), it is conscious.

IIT, by contrast, focuses on the ability of an entity to create change, to be an agent with causal power, and also on the way information is stored within that entity. In Koch's opinion, AI has little or no causal power – only the imitation of it. So while these tools can mimic how humans speak and interact, they aren't agents of change and therefore aren't conscious.

"Koch's focus has been on understanding the biological mechanisms that underlie consciousness"

Koch writes: "Consciousness is the launching pad for everything else – not its physical substrate, the brain. This starting point is what makes [IIT] so different from contemporary theories that start with the brain and then seek to squeeze the juice of consciousness from it using computational functionalism."

Simulating consciousness, then, no more produces consciousness than simulating gravity produces gravity's raw causal powers, he says. This view may be unfortunate for AI-obsessed investors, but is plausible despite the billions weighing against it.

Koch's own focus has been on understanding what he calls the neural correlates of consciousness – the biological mechanisms that underlie it. To date, these have proved elusive, though the possibility that they exist drives his arguments.

Yet despite the effectiveness of Koch's arguments and the evidence he gives to support his views, at times he seems guilty of the conceptual biases he notes in others. For example, he dismisses philosophy as a field that moves too slowly without approaching consensus on such important questions as how to define the mind. As a recovering philosopher, I sympathise, but believe that view is unwarranted.

Koch also makes contentious claims about psychedelic drugs, like LSD and psilocybin. He argues that they lead to expanded consciousness, much like religious rites or the near-death experience of my train companion. Despite Koch's clear and impassioned defence of these claims, I found them unconvincing, and it is around these sections that his writing becomes a bit over the top.

Nonetheless, *Then I Am Myself the World* is an impressive and sometimes exuberant work, showcasing decades of his research – and that of others – that has effectively bridged many fields to lead to a cohesive view of the human mind. If I ever see my train companion again, I hope to more fully answer his questions. ▮

Psychedelic drugs are said to lead to expanded consciousness

JORM SANGSORN/ISTOCKPHOTO/GETTY IMAGES

Jonathan R. Goodman is a writer and an interdisciplinary researcher at Darwin College, Cambridge, and at Cambridge Public Health

The Amazon fights back

Activist Nemonte Nenquimo's autobiography reads like a compelling novel, but it's really insider anthropology, says **Kate Douglas**

Book

We Will Not Be Saved
Nemonte Nenquimo with Mitch Anderson
Wildfire (UK, on sale)
Abrams Books (US, 17 September, as *We Will Be Jaguars*)

JERÓNIMO ZÚÑIGA/AMAZON FRONTLINES

Nemonte Nenquimo (centre) alongside other members of the Indigenous-led Ceibo Alliance

AUTOBIOGRAPHIES rarely appear in *New Scientist*'s culture pages. This one, however, isn't just unusual, it is ground-breaking: the first book of its kind to be written by a member of the Waorani people, an Indigenous Amazonian group. Humans have been recording their life stories for over four millennia, so it is about time we heard from people like Nemonte Nenquimo. What she has experienced, while still only in her 30s, is astonishing.

Nenquimo is famous for her work as an environmental activist. It won her a place on *Time* magazine's list of the 100 most influential people of 2020. That is a colossal achievement, but her book, *We Will Not Be Saved: A memoir of hope and resistance in the Amazon rainforest*, reveals her to be impressive in many ways, including in her ability to spin a good yarn.

The book (written with husband Mitch Anderson) is beautiful and gripping. It reads like a novel, but is really a fascinating work of cultural anthropology, told from the inside. Nenquimo is a force of nature, and her story encompasses the best and worst of humanity – from power politics and deadly tribalism to collectivism and ingenuity.

It starts when she is 6 years old, living in the Pastaza region of the Ecuadorian Amazon, with her family (part of the Waorani nation) and a menagerie of animals. A US missionary – the improbably named Rachel Saint – has turned up and is attempting to force her worldview on the villagers.

An inquisitive, intelligent child, Nenquimo is keen to explore what the "Land of Rachel" has to offer. Suffice to say, it doesn't go well. Dentistry, with chisel, hammer and pliers, is excruciating. Her fascination with lipstick is severely punished. And, when she runs away to join a mission, aged 14, she is repeatedly sexually assaulted.

Meanwhile, missionaries aren't just after the souls of Indigenous people, they also want their land. And not far from Waorani territory, Big Oil has made inroads (literally) into the jungle, throwing up shanty towns, replacing lush forest with parched pasture, poisoning rivers and polluting the soundscape with the thrum of drilling. The result is an almighty culture clash.

One small but telling example is how incomers co-opt the local word *auca* to name their hotels and roads – and that Saint uses it to refer to the villagers. "Auca is actually the word the Kichwa [community] use for the Waorani," writes Nenquimo. "It means savages."

Eventually, pushed beyond endurance, Nenquimo leaves the mission. It takes her seven years to recover from the ordeal: "I had dispensed with their white dresses and their prayers but not the stains on my spirit, not the shame, not the pain." Her real crusade begins. As a child, she was told missionaries had come to save the Waorani. Now, reconnecting with her culture, her family and the forest, she realises that Indigenous peoples must save themselves – and they can only do so by working together.

Given the recognition Nenquimo has received, it is no spoiler to say her environmental leadership has had remarkable success. *We Will Not Be Saved* details her co-founding of the Ceibo Alliance, a coalition of Indigenous Amazonian communities, and how, in April 2019, it won a lawsuit against the Ecuadorian government to protect half a million hectares of rainforest from oil exploration and drilling.

Nemonte means "many stars" and the name is apt. She shines brightly. Her experience is testament to the power of curiosity and an indomitable spirit, and the way she and the Waorani see the world is inspiring. To be immersed in Nenquimo's story is a privilege – even if it can make uncomfortable reading for Westerners. ▮

New Scientist *recommends*

Tim Boddy
Picture editor
London

I have recently had a double helping of botanical culture, starting with a terrific exhibition at Tate Britain, London. **Now You See Us: Women Artists in Britain 1520-1920**

puts a spotlight on female artists, many of whom have been unfairly forgotten, and challenges stereotypes.

Within the exhibition there is a section on flowers, including Mary Delany's collages. Naturalist Joseph Banks said that her works were the only botanical images from which he could reliably identify a plant species.

Other highlights include detailed watercolour paintings of fruit by Augusta Innes Withers. I don't think I've seen a better example of light hitting grapes (pictured). You have until 13 October to visit.

I have also been captivated by **Where the Wildflowers Grow**, a book by botanist Leif Bersweden describing a year-long journey around the British Isles, exploring the region's plants and their rich history.

AUGUSTA INNES WITHERS/RHS LINDLEY COLLECTIONS

The sci-fi column

A tale of two halves

Jurassic Park and *ER* made Michael Crichton a household name. When he died, he left behind a manuscript, which thriller writer James Patterson was asked to finish. Does the result, *Eruption*, work, asks **Emily H. Wilson**

Emily H. Wilson is a former editor of *New Scientist*. *Gilgamesh*, the second novel in her *Sumerians trilogy*, is out later this year. You can find her at emilyhwilson.com, or follow her on X @emilyhwilson and on Instagram @emilyhwilson1

TOMAS MICEK/ALAMY

Lava flowing from Kīlauea, a shield volcano in Hawaii

IF YOU were the person behind the long-running TV show *ER*, and also had the idea for *Jurassic Park*, you would be pretty proud of yourself, right? Now imagine you came up with those, plus *Westworld*, *Twister* and a host of other blockbusters.

That would make you Michael Crichton, of course. And what a spectacularly creative person he was. In 1995, he could lay claim to the US's top-selling book (*The Lost World*), number one movie (*Congo*) and number one TV show (*ER*).

Towards the end of his career, he appears to have taken a swerve into climate scepticism – never a good look – but, nonetheless, he remains a titan of popular culture, with *Jurassic World* (née *Park*) still a thriving franchise.

Now Crichton has a new book out... sort of. When he died in 2008, he left behind an unfinished manuscript. His widow, Sherri Crichton, eventually enlisted the thriller writer James Patterson, one of the best-selling authors ever, to finish the book.

Fast-forward and we have *Eruption*, a novel billed as "the blockbuster thriller of 2024" and "a collaboration like no other". It tells the story of a Hawaiian volcano that is about to blow and the volcanologists fighting to control the coming explosion. To tell you why they want to control it and how they plan to do so would spoil the plot.

So, is it any good?

In brief, no. It's a logistics-based drama that never rises above said logistics. These are the things we could do to control the explosion...

"*Eruption* may well become a film, as so many of Michael Crichton's previous books have"

OK, we are doing the things. The only mystery is: will these cardboard-thin characters be successful in their logistical efforts? Plus, the reason for the scientists interfering with the volcano in the first place feels like part of the plot of a different book.

Eruption does whip along: Patterson is a fan of short chapters, and that helps a book go down easy. However, I remained untouched by the characters and the story. All of which is a great shame when not one but two writers have put a huge amount of work into something. But there it is.

Of course, how we react to a piece of art is entirely subjective. To try to understand why I was left so cold by the book, I went back to read *The Lost World*, which was such a hit for Crichton in 1995.

The novel starts inauspiciously with a scientist giving a lecture. It is almost actively reader-unfriendly in its construction. Yet before I knew it, I was on page 100. Dead dinos were washing up in Costa Rica, but the evidence was being hushed up. You would need to be a dead dino not to read on.

So, yes, this reappraisal confirmed my suspicion: however much volcano science, exploding lava and helicopter action has been thrown into the mix, the story of *Eruption* just isn't inherently sexy enough.

None of this is likely to harm the book's prospects, given the publicity power behind it. Many readers might also disagree with me about the book – Patterson fans, perhaps, or people with more of an interest in volcano science. It may well also become a film, as so many of Crichton's previous books have.

In fact, *Eruption* does read like a film script, and with fantastic actors adding interest to the characters, as well as amazing volcano visuals, I can easily see myself munching popcorn through the movie version. You may wish to wait until then before engaging with this story. ▮

Book

Eruption

Michael Crichton and James Patterson

Century (UK)

Little, Brown (US)

Emily recommends...

Book

The Letters of the Younger Pliny

Penguin Classics

Should you wish to read a heartrending account of a volcano erupting, Pliny the younger's wonderful collection of letters includes his eyewitness report of the devastating explosion of Vesuvius in AD 79, in which his uncle was killed. "We rose from time to time to shake [the ashes] off," he writes, "otherwise we would have been buried and crushed beneath their weight."

Editor's pick

Ageism is alive and well in many walks of life

18 May, p 32

From John Grant, Caloundra, Queensland, Australia

You recently raised the issue of ageism. Approaching octogenarian status, I don't think of myself as old and nor do my fellow surfing mates. However, try applying for a new credit card or travel insurance (in Australia at least) and it is a totally different story. The hurdles to jump over for a credit card are incredible, whereas a younger person can walk into a bank and come out with one straight away. As for travel insurance, the premium is almost as much as the trip.

What these institutions are saying is that they don't want you as their customer – that you are too old. When it comes to banks and insurance, ageism is alive and well.

From Paul Lea, Broadclyst, Devon, UK

A few years ago, I took issue with a survey that allowed people discretion when it came to questions of nationality, ethnicity, gender and so on, but not age. I find the apparent belief, commonly espoused in the media, that people over a certain age need to be treated differently to others highly condescending and insulting. As Clem De Pressigny points out, ageism is arguably the last prejudice considered acceptable.

Smells like an excuse to continue business as usual

18 May, p 14

From Sara Harrington, Woodbridge, Suffolk, UK

Your report that farmed pigs appear to find life less of a struggle when they can smell a pleasant odour is frankly sickening to read.

This farming is undoubtedly for pork production, where young pigs are castrated, overcrowded and have no access to exercise in the natural world. These animals become aggressive to other pigs and self-harm.

That isn't green or ethical farming. Surely the real story is why this is allowed to carry on?

More possible ways to offset carbon from flying

11 May, p 22

From Susan Payne, Cape Elizabeth, Maine, US

Like Graham Lawton, my views on offsets to balance carbon emissions from flying evolved from interest to scepticism. How do we know these programmes have substantive, long-lasting impacts? We don't.

However, there may be a more effective solution than either not flying or waiting for offset programmes to prove their effectiveness: we can shift our focus to supporting renewable energy. Instead of evaluating offsets, I pay extra via my electricity bill into the state-wide Maine Green Power programme. The money goes directly to purchasing renewable energy. I figure that makes up for the carbon emissions associated with my flights.

It takes a bit of investigation, but I bet there are similar options in other places, for homeowners and renters alike.

From Steve Allam, Kingsclere, Berkshire, UK

I applaud Lawton for outing flight offsetting programmes as greenwashing. As many of these projects are fairly obscure and the market for carbon credits is equally murky, consumers are put off any form of offsetting, which is also a problem. Similarly, many people are stuck with an oil or gas boiler and a petrol or diesel car, at least for the next few years – what can they do?

I would suggest that the best form of offsetting is to donate to projects and charities that are working in the right direction – for example, by improving cooking stoves in lower-income countries. One resource for such projects is the UN Carbon Offset Platform.

Let's try bathing our streets in a lemony hue

Letters, 18 May

From Philip Belben, Nettlebridge, Somerset, UK

May I add an additional consideration to the debate about LED street lighting? In the days of sodium lamps, it wasn't unusual to fail to notice an amber traffic light among the street lamps. This was exacerbated if the shape of the road and height of the lamps meant that the traffic light appeared to continue a line of street lamps.

Now that white LEDs have become common, the confusion that may arise is between street lamps and car headlights. This is another argument in favour of coloured LEDs. Such LEDs can be more efficient than white ones. We would need to choose a colour that is unlikely to result in confusion with other lights on the road. I wonder whether the more distinctive lemon-yellow of early LEDs might do the job.

Blame climate change for the end of civilisations

11 May, p 32

From Dylan Bickerstaffe, Loughborough, Leicestershire, UK

In my view, the ultimate source of civilisation-ending events, of the sort detailed in your look at the downfall of eastern Mediterranean Bronze Age societies, is invariably drastic climate change. As your article says, "so much chaos, simultaneously, is surely no coincidence", and while clear-cut evidence for climate catastrophe is currently lacking, so are any other plausible causes for the collapse of long-standing Bronze Age civilisations.

It surely beggars belief that people who had lived for hundreds of years under Mycenaean-style palace states should choose this time to rise up "because they want[ed] a more egalitarian and uncomplicated society".

Tripling down on cosmic unknowns

18 May, p 8

From Stephen Rowe, Shepperton, Surrey, UK

So cosmology may now need "dark radiation" as well as dark matter and dark energy. But the only reason these three imaginary fiddle factors are required to make observational data fit the standard cosmological model is because gravity is assumed to be constant everywhere.

When you have to imagine and include three unobserved physical processes in a theoretical model, most rational people would start to believe that we are using the wrong model.

Another vote against alien megastructures

18 May, p 12

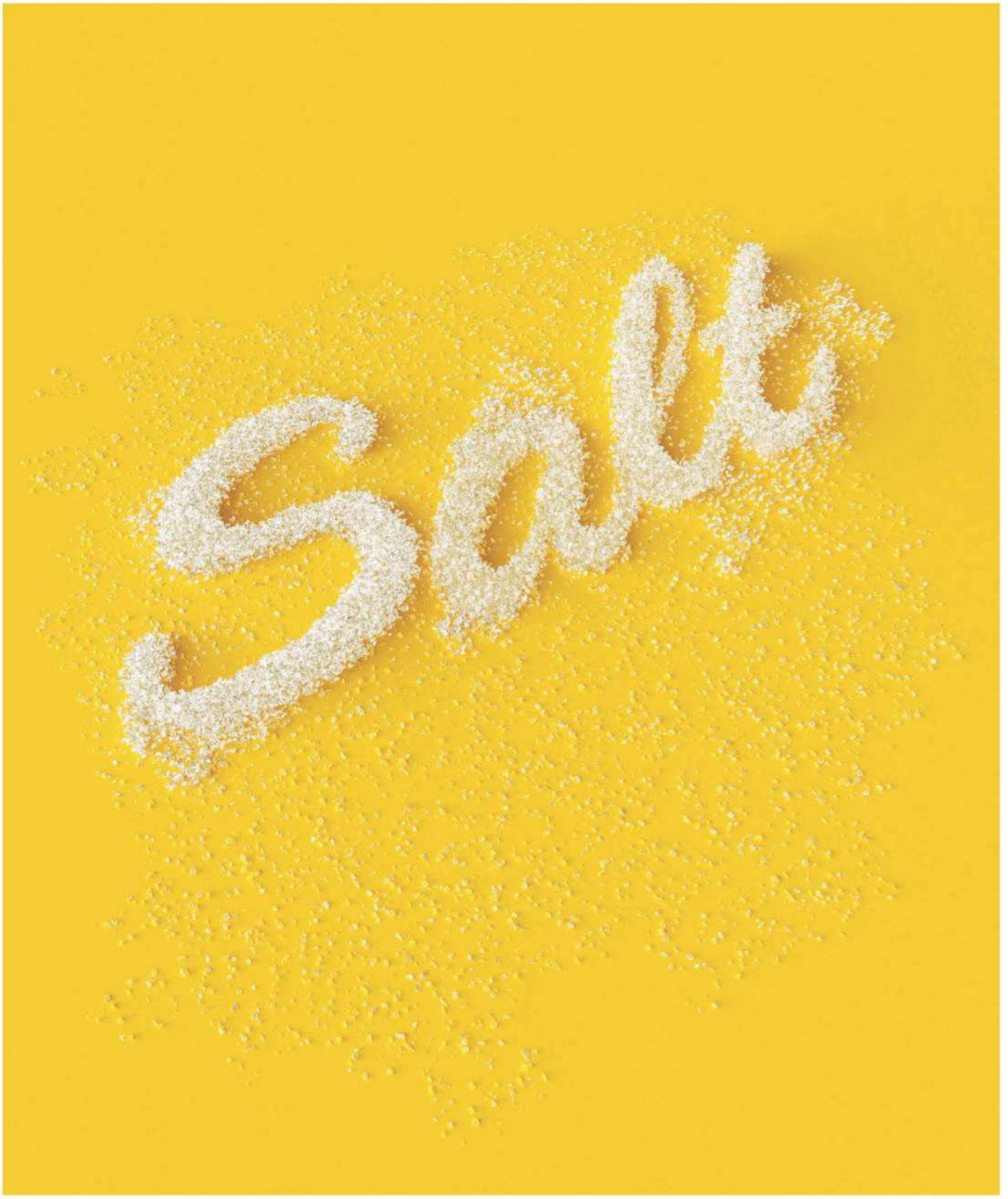
From Jim McHardy, Clydebank, West Dunbartonshire, UK

Dyson spheres and Dyson swarms are a means of collecting massive amounts of energy from a star to power an alien civilisation. Surely any advanced society would have arranged to minimise the use of energy, as we are trying to do on Earth, so why would it need the whole or a large fraction of a star's power? Presumably to run the air conditioning to keep themselves from melting. ▮

Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, 9 Derry Street, London, W8 5HY will be delayed



LISA SHEEHAN

The salt fix

We have a new target in our war against dietary sodium, and this one is much more palatable, finds **Graham Lawton**

I HAVE high blood pressure and have been taking medicine to control it for years. It recently spiked again and my doctor tweaked my prescription. But I have also been taking matters into my own hands, limiting how much salt I eat, plus a bit of self-medication with an off-the-shelf supplement. My blood pressure is back under control.

You might think that it was the medication and my salty sacrifice that did the trick. They almost certainly played a part. But my supplement of choice – potassium – may have actually done the heavy lifting.

High blood pressure, or hypertension, is the world's most common cause of death. And while there is little doubt that excess dietary salt (sodium chloride) can elevate blood pressure and that most people would benefit from eating less, many of us struggle to do so. We urgently need a better solution, and growing evidence suggests we may have one in potassium.

"Potassium is really important," says Bruce Neal at the George Institute for Global Health in Sydney, Australia. "There's no doubt that potassium will lower blood pressure."

Understanding exactly how it works, how much we should consume and its effect on blood pressure is of growing interest to researchers, who are starting to realise the huge impact it could have in fighting our global battle against cardiovascular disease. Have we finally discovered a more palatable way of satisfying salt cravings that won't damage our health?

According to the NCD Risk Factor Collaboration, which provides data on non-communicable diseases, around 1.2 billion adults worldwide have high blood pressure and more than 10 million people a year die as a result, mainly through cardiovascular and kidney disease.

The causes of hypertension remain largely uncertain, but its consequences are clear. When blood pressure is high – above 130/80 millimetres of mercury (mmHg) – the heart has to pump harder, arteries get stretched and battered and the kidneys have to work at a higher rate to filter the blood. Over the long term, this causes irreparable damage to the organs and blood vessels. Most cases are idiopathic, meaning of unknown cause, but one risk factor has been clearly identified: excess intake of salt.

Not everyone is sensitive to salt, but for the 50 per cent of the population who are, there is a linear relationship between sodium intake and blood pressure. Salt sensitivity is partly genetic and also more common in older people, women, African Americans and those with insulin resistance or chronic kidney disease.

For them, each extra gram of sodium chloride per day (which equates to 2.5 grams of table salt) increases blood pressure by an average of 2.1 mmHg. The rise is even greater in people who already have hypertension and the over-60s. Around 30 to 50 per cent of people with hypertension are salt-sensitive.

Unsurprisingly, reducing dietary sodium causes blood pressure to fall. But salt reduction strategies have faced many challenges. In the early 2000s, a team led by Lawrence Appel at Johns Hopkins University in Maryland ran a short trial of an intervention called Dietary Approaches to Stop Hypertension (DASH). Over 30 days, volunteers ate a diet either high, medium or low in sodium and had their blood pressure monitored. Those on the low-sodium regime – with less than 3 grams of salt per day – saw their blood pressure fall by an average of 6.7 mmHg compared with the high-sodium intake. That was true whether they were hypertensive or not.

The DASH study was highly influential, according to Franz Messerli at the University Hospital of Bern in Switzerland. Numerous bodies, including the World Health Organization, now recommend eating no more than 2 grams of sodium per day,which is roughly 5 grams of regular table salt. That is about a 40 per cent reduction on the intake from the average Western diet of 8.7 grams a day.

However, doubts remained over the wisdom of salt reduction. Some naysayers pointed out that the change in blood pressure per gram of salt is small and that around half of people aren't salt-sensitive. They also claimed there was evidence suggesting that eating too little sodium is worse for health than eating too much.

Controversial advice

DASH didn't put that controversy to bed. So in 2014, Neal and his colleagues at the George Institute decided to get to the heart of the matter. They approached communities in rural China and invited them to join a vast clinical trial called the Salt Substitute and Stroke Study (SSaSS). They got 600 villages on board, and within each recruited around 35 men and women in late middle age, most with a history of hypertension or stroke. There were 20,995 participants in total.

In rural China, processed food is largely unavailable and most dietary salt is added during food preparation or at the table. So the researchers gave participants in half of the villages a free supply of low-sodium salt – comprising 75 per cent sodium chloride and 25 per cent potassium chloride – and asked them to use that instead of regular salt for cooking, seasoning and preserving. The other 300 villages carried on as normal without any interventions.

Over the course of more than four-and-a-half years, the researchers tracked the ›

"Adding potassium to your diet is such a low-cost intervention. The potential benefits are huge"

number of strokes, other major cardiovascular events and deaths from all causes, including kidney disease. All three were significantly lower in the low-sodium group. "It's a fantastic study, it shows a huge impact," says Kenji Shibuya at the Tokyo Foundation for Policy Research, a Japanese research-based think tank.

After the results were announced at the 2021 European Society of Cardiology Congress, Bryan Williams at University College London, who is also chief scientific and medical officer at the British Heart Foundation, commented: "Those who doubted the benefits of salt restriction for cardiovascular disease prevention were wrong, the debate stops here."

The debate didn't stop though. More detailed analyses of the results suggested we had missed a trick. While they supported the headline finding that salt substitution reduces the risk of cardiovascular disease, and that sodium reduction is part of the reason why, they also pointed to a more significant factor: potassium.

The idea that potassium has an important influence on blood pressure has been around for a long time. In the 1970s, George Meneely at Vanderbilt University in Tennessee hypothesised that humans evolved to eat much more potassium and much less sodium than we do now, and that the dietary ratio of sodium to potassium was an important factor in blood pressure. Subsequent studies showed that people who consumed more potassium had lower blood pressure, and clinical trials have since confirmed the link. "There's a whole bunch of trials which also suggest that potassium intake is good for you," says Neal.

This beneficial effect in part occurs via a process in the kidneys called the "potassium switch". When potassium levels in the bloodstream are low, the kidneys block excretion of it into urine, which also suppresses sodium excretion. Higher potassium levels, on the other hand, help the kidneys to get rid of excess sodium, which is what a class of medications known as diuretics can do too. "Potassium acts like a natural diuretic," says Swapnil Hiremath at the University of Ottawa in Canada. Potassium also exerts a direct effect on blood pressure by relaxing blood vessels, he says.

A surprising finding

Potassium was a major factor in the SSaSS study. The salt substitute used in the experiment not only lowered the participants' sodium intake, it also increased potassium. In fact, says Messerli, the average reduction in sodium was only 8 per cent, but potassium increased 57 per cent. And here is the twist: when Neal, Liping Huang at the George Institute and their colleagues reanalysed the data from the SSaSS study, they concluded that about three-quarters of the effects were derived from potassium supplementation and only a quarter from sodium reduction.

"Although population-level potassium intake has received less attention than sodium intake as a public health strategy, the results of the recent SSaSS trial might suggest that increasing potassium intake may be of greater importance," says Catriona Reddin at the University of Galway in Ireland.

Lack of dietary potassium is a global problem. Current guidelines advise adults to eat about 3.5 grams per day, but global average intake is 2.25 grams per day and only 14 per cent of the world's population hit the target, says Reddin. The main reason for that is a lack of fresh fruit and vegetables, plus the fact that cooking and processing food can cause potassium to leach out.

As yet, however, none of this evidence has fed through into health advice to lower blood pressure. "Potassium just isn't used in the same way [as sodium], so hasn't been thought about as a target," says Neal.

How to boost your potassium

Cutting down on salt is beneficial for most people, but can be difficult. Consuming more potassium can offset some of the problems that excess salt causes (see main story). Measuring how much potassium is in your diet isn't easy, but most people don't get enough and overdoing it is difficult, unless you have kidney disease. Here are some easy ways to boost your intake to the recommended 3.5 grams per day.

Switch to potassium-enriched salt

Eat more fresh fruits and vegetables, which are the richest dietary source of potassium available and have many other health benefits

Bananas are widely known to be a good source of potassium, but papaya and prunes are also high in it, as are beans, peas, nuts, spinach and sweet potatoes

Consider taking a potassium supplement if it is medically appropriate

You may need to consult your doctor before taking supplements or making major dietary changes.

MARTIN SKULTETY/IMAGE PROFESSIONALS GMBH/ALAMY

New Scientist audio
You can now listen to many articles – look for the headphones icon in our app **newscientist.com/app**

MIXETTO/GETTY IMAGES

Switching to high-potassium salt could lower blood pressure

Another reason for reticence around potassium is a serious health condition called hyperkalemia, or excess potassium in the bloodstream, which can cause sudden death from cardiac arrhythmias. But this is a minuscule risk, says Neal, and one that is hugely offset by the benefits of consuming more potassium. The SSaSS study monitored volunteers for hyperkalemia and found no difference between the two groups. The condition is a particular risk for people with advanced kidney disease because they struggle to excrete potassium. However, they are already advised to avoid salt, says Neal.

Neal and others are now eyeing potassium as a new target in the global battle against hypertension. This is in part an admission of defeat on sodium reduction, which has been attempted repeatedly, but invariably falls short. "The fact is, we have struggled," says Hiremath. "Sodium intake has not budged despite decades of guideline recommendations."

There are various reasons for this. "You've either got to persuade individuals to buy less salty foods or to add less salt to food when they cook, and it just doesn't happen," says Neal. "Or you've got to persuade industry to put less salt in processed foods and there's simply no incentive for them to do that. Or you've got to persuade governments to regulate salt levels, but, in general, the appetite for governments to do that is pretty much zero."

The SSaSS study points to a way to surmount all of those obstacles. Potassium-enriched salt can be used in exactly the same way as regular table salt, in exactly the same quantities, so doesn't require obvious lifestyle changes. A 75 per cent potassium/25 per cent sodium mix tastes very similar to regular salt, with the sodium chloride masking the bitter and metallic taste of potassium chloride.

The price isn't too difficult to swallow, either. In the UK, a version called LoSalt, which is 73 per cent potassium chloride, retails for around £6.30 per kilogram. The same quantity of the cheapest sodium chloride costs £1.17. "It is slightly more expensive than plain sodium chloride, but it's not insanely expensive," says Hiremath.

Public health messaging around potassium chloride is also easier, he says. "Saying 'eat less of this, less of that' is patronising and paternalistic. Potassium allows the message to be, OK, if you cannot decrease salt, add a little bit of potassium in your diet."

The blood-pressure-lowering effect of potassium means that people can continue eating too much sodium chloride but partly offset it with potassium, either in their diet or in supplements (see "How to boost your potassium", left). "People love supplements," says Hiremath. "The fun thing is that you don't have to change your diet. You can eat the same things as before, just add a potassium supplement and that may be enough to reduce your blood pressure."

A simple solution

"Our message is switch," says Neal. Five years after the SSaSS study ended, 93 per cent of people assigned the potassium-rich salt were still using it, he says. "That's staggering."

The biggest win of all would be to persuade restaurants and processed food companies to make the switch too. That would be especially effective in higher-income countries where around 80 per cent of sodium consumption comes from salt added during the industrial manufacturing of foods. However, that will take some doing, says Neal, largely because of the increased cost of using high-potassium salt.

That is where governments come in. Last year, the US Food and Drug Administration changed its rules to permit use of potassium-enriched salt in processed foods. More of the same is needed, says Neal. "I believe we should switch the world salt supply from regular salt to potassium-enriched salt," he says. Something similar has been achieved before with universal iodisation of table salt to prevent foetal and developmental abnormalities, goitre and hyperthyroidism due to lack of dietary iodine. In 1960, around 60 per cent of the global population was deficient in this mineral. Nowadays, thanks to extensive efforts by governments and public health bodies, that problem has largely disappeared.

Governments have a huge incentive to get on board with potassium. Extrapolating the SSaSS result globally suggests that universally switching to potassium-enriched salt would prevent between 6 and 7 million strokes and heart attacks each year, says Neal. "It's such a low-cost intervention. The potential benefits are huge." ▮

Graham Lawton is a staff writer at *New Scientist*

The happiness trap

The idea that we should always look on the bright side has gone too far and may now by damaging our well-being, finds **Conor Feehly**

ARE you struggling with low self-esteem? If so, you may have been told to repeat phrases such as "I am a loveable person, I am a loveable person, I am a loveable person". Positive chants like this, known as self-affirmations, are said to boost a person's mood and feelings of worth. You might think that sounds too good to be true – and you would be right. When psychologists tested the effects of this very mantra, they found that it backfired. Those participants who started out with low self-esteem ended up feeling worse. The problem was that they simply didn't believe what they were saying.

We know that a positive attitude can be good for us and that the right mindset can have a real impact on our health and happiness. But it turns out that we can have too much of a good thing. What those psychologists studying self-affirmations found was an example of "toxic positivity" – the idea that a forced optimistic interpretation of our experiences alongside the suppression of negative emotions can do real damage. The term has become something of a buzzword in both academia and pop culture. Yet despite this, messaging that "happiness is a choice" and "positivity is a mindset" abounds.

What's required is a rebalance. It isn't enough to say that excessive positivity can be toxic. We need to know when that is the case, why and for whom. Luckily, there is a growing body of research addressing these questions. Armed with this knowledge, we can make healthier choices that help us avoid toxic positivity, both for ourselves and for society as a whole.

Our tendency to eschew the darker aspects of human experience isn't new, especially in Western societies. Longstanding rules about how we display our emotions have led people to develop strategies to avoid negative ones, says Susan David at Harvard Medical School, who calls this the "tyranny of positivity".

Beginning in the industrial revolution, socioeconomic goals around productivity and efficiency contributed to a culture

> "'Toxic positivity' has become a buzzword in both academia and pop culture"

where emotions, especially paralysing ones like sadness, were seen as handbrakes to economic output: "keep calm and carry on", as the saying goes. "Faith, religion and, to a degree, magical thinking also played a part," says David. If someone was struggling, they were exhorted to have more faith rather than encouraged to explore the root causes. Science must also take some blame. Historically, psychologists didn't consider emotions as valid phenomena to study, so there was little understanding of the important effects they have on our mental state.

Fast-forward to 1998 and the emergence of the positive psychology movement. This marked a big advance for psychological research in general because it shifted the focus from studying mental health conditions and negative thinking towards the things people needed in order to flourish. Even so, positive psychology has been criticised for various reasons, including overstating the degree to which we have control over our emotional states and assuming certain emotions are inherently good for us and others inherently bad. Initially, it also overlooked the role that negative emotions play in our overall psychological well-being, although this failing was addressed as the field matured.

In large part, proponents of the "happiness is a mindset" mantra have echoed a simplified, pop version of the early insights of positive psychology. They urge us to inject a bit of – insert positive emotion here – into our day to harness the benefits. They tell us that our psychology can be "hacked" through a positive mindset. And they counsel anyone having a bad time with trite phrases such as "it's going to be OK" and "focus on the good things". In its worst incarnation, it preaches the pseudoscientific idea that you can "manifest" material comfort and health through thought alone. Known as the "law of attraction", this has been promoted in self-help books.

Perhaps it isn't surprising that we want to ›

DEEPOL BY PLAINPICTURE/ANJA WEBER-DECKER

believe things will turn out better for us if we have a positive attitude. After all, there is a growing body of research indicating that an optimistic outlook on life does have benefits. For example, the right mindset can trigger physiological changes that can help you become fitter, more energetic and less stressed. It is also well established that psychological stress can have detrimental effects on the body, from the cardiovascular and nervous systems to hormones and reproduction. The state of your mind undoubtedly affects the state of your body, and vice versa.

Hijacked by emotions

It also isn't surprising that we consider certain emotions to be inherently bad, because those like anger, guilt, fear and resentment do feel unpleasant. When we experience them, we can become consumed, agitated or paralysed with inactivity. Such negative emotions can leave us feeling as though we have been robbed of our agency to interact with the world in a measured, meaningful way. It can seem like we have been hijacked by our emotions.

Nevertheless, it is becoming apparent that positivity has its limits. In 2021, a meta-analysis (a study of studies) with a combined total of more than 217,000 participants investigated the link between optimism, pessimism and mortality. It found that an optimistic outlook was indeed associated with lower instances of death from any cause over the course of the studies. However, both unrealistic optimism and pessimism were linked to a higher risk of mortality.

What's more, a large body of research now demonstrates that ignoring negative emotions can be harmful to our mental well-being. In one study, published in 2022, an international group of psychologists explored how societal pressure to be happy affects people in 40 countries. They found that it can be detrimental to our psychological well-being when we inevitably experience negative emotions. This was particularly the case in countries with high national happiness levels, as measured by the World Happiness Index.

Social media and the positively curated images of ourselves we create online add to this pressure to be happy, says Brock Bastian at the University of Melbourne in Australia, who was part of the research team. "When we are not willing to accept negative emotions as a part of life, this can mean that we may see negative emotions as a sign there is something wrong with us," he says. In other words, with an overemphasis on positivity, we are more likely to perceive normal emotions, such as sadness and anxiety, as signs of a mental health condition needing treatment.

Research by Maya Tamir at The Hebrew University of Jerusalem highlights another reason why excess positivity may be toxic. She and her colleagues studied more than 2300 people from eight countries to explore whether the secret of happiness lies in experiencing more pleasant emotions or, as Aristotle argued, in experiencing the emotions we want to experience. They found that, regardless of culture, greater mental well-being is linked with feeling emotions that we believe are appropriate to our situation, rather than just having positive emotions regardless of context – "feeling right" as opposed to "feeling good", is how they put it. We should be concerned if we don't feel angry when we witness someone being exploited, for example. Such emotional episodes, while experientially unpleasant, indicate that we are ready to behave in accordance with our values.

For Tamir, emotions can be thought of as a toolbox that helps us attain those goals that are important to us.

Tamir is particularly interested in how and why people regulate their emotions. She believes that to understand this, you need to know how they want to feel in different contexts. "I think that people do want to feel good, but I think there are several different definitions of good," she says. In the context of emotions, "good" can mean the presence of pleasurable emotions, but it can also involve things that are helpful and things that are meaningful, she adds. And emotions that are helpful or meaningful often aren't pleasant while you are experiencing them.

That isn't to say that we don't try to regulate unpleasant emotions. We are often confronted with unwanted feelings – we might be nervous before speaking in public, for example, or guilty because we have neglected a relationship – so we develop strategies such as suppression and avoidance to help us change our emotional state. For other emotion researchers, toxic positivity is a form of suppression that tells us we can alter how we feel by sheer force of will. "Part of why positive thinking has erroneously embedded itself within Western ideas of what it means to be psychologically healthy is because it centres around a narrative that you are in control of your emotions," says David.

The message that you are in control of how you feel may seem empowering, but, whether we like it or not, there are things

ROBIN UTRECHT/SHUTTERSTOCK

Life can be tough and pretending otherwise can backfire

STEVE MCCURRY/MAGNUM PHOTOS

Listen to a friend's woes and you will both feel better

> "Emotions that are helpful and meaningful often don't feel pleasant"

outside of us that influence our emotional state. Throughout our lives, we will have relationships that end, we will face loss and disappointment, and some days we will just feel down without knowing why. "So-called negative emotions are an inevitable part of the human experience, they are unavoidable," says David. The idea that we can simply suppress them stigmatises those who are suffering, and those with mental health conditions, as lacking willpower or being mentally weak.

Escaping the tyranny

It also divides people along socioeconomic lines. Many studies show that socioeconomic status is linked with people's feelings of control over their lives, and psychologists have found that worse-off individuals tend to see their situation as caused by bad luck – they have what is known as an external locus of control. By contrast, people who are doing well in life tend to attribute their good fortune to hard work and the choices they have made. This internal locus of control makes wealthy individuals more predisposed to messages of positive thinking. And, of course, they have the resources to prop up a self-help industry that tells them what they want to hear: that they are the architects of their own well-being.

How can we escape the tyranny of positivity? David points out that while suppressing negative emotions is harmful to psychological health, we must be careful not to go too far the other way. Dwelling on negative emotions, or rumination, isn't a healthy strategy either because we can get stuck in circular loops of reasoning where we feel bad for feeling bad. Instead, she says, we need to be able to sit with uncomfortable emotions, accept them as a normal part of human experience, and learn to understand that they play an important role in our mental health.

Research shows that when people accepted their negative emotions – rather than judging mental experiences as being good or bad – they became more emotionally resilient, experiencing fewer negative feelings in response to environmental stressors and attaining a greater sense of well-being.

Acceptance as a strategy for regulating emotions entails not judging oneself for feeling negative emotions but simply experiencing them and understanding that they will pass. The good news is that, as we age, we increasingly rely on acceptance – which might help explain why older people tend to report better emotional well-being.

But, says David, given the right environment, acceptance can be nurtured from a young age. What's needed, she argues, is a "secure base". When we have a support network that tells us it is alright to feel a certain way, we can explore ways to cope with negative feelings and to inhabit new emotional spaces, without judgement.

Witnessing a child, partner or friend in distress can be painful, and helping them to develop healthy strategies to regulate their emotions often involves having difficult conversations. But offering inauthentic advice such as "just be positive" is likely to backfire. It may make you feel better but, as that study on self-affirmations revealed, when people are most in need of a boost, forced positivity can make them feel worse. "When we tell someone to 'just be positive', we are telling them that my comfort is more important than your reality," says David.

Instead, when someone close comes to you in a time of emotional turmoil, one of the best things you can do is listen. Surprisingly, that simple act won't just help them, it could also benefit you. When researchers scanned people's brains when they and a partner were exposed to distressing images, they found that allowing someone who is experiencing negative emotions to feel heard and vent reduced stress in the listener as much as in the speaker.

While trying to rebalance the way we think about and experience emotions, we shouldn't throw out positivity altogether. The right amount of it in the right place and at the right time can work wonders. But we also need to allow space for people to accept the adversity that comes with life. Resilience and growth are attained when we fight through difficult situations. "It's not about control over our emotions, but moving to a place where we can understand their wisdom," says David. "Our emotions reveal our values to us, who and what we care about. Having the tools to reach a point of acceptance with our emotions is part of what it means to be psychologically healthy." ▮

Conor Feehly is a freelance journalist based in Bangkok, Thailand.

GRAHAM CARTER

BACKWARDS STUFF

Strange new materials that act as "mirrors in time" are proving to be a testing ground for some of the most exotic ideas in physics, finds **Jacklin Kwan**

FOR an experiment designed to reverse time, the apparatus was surprisingly simple: little more than a tank of water. With a puff of air to disturb the surface, Emmanuel Fort created a set of ripples moving outwards in concentric circles. Then, as the waves spread, he gave the tank a practised jolt – at which point they suddenly started travelling inward, refocusing at the point of origin.

Fort's work in 2016 was the first of what has become a deluge of experiments in which waves are manipulated, controlled and even reversed with unprecedented precision. And these days, we are no longer just playing with water. Researchers have figured out how to create a range of "temporal metamaterials" that can manipulate and rewind electromagnetic waves, including visible light itself, with ever greater precision.

The key to these bizarre materials isn't so much the careful engineering of their spatial arrangement of atoms, but how they work in the fourth dimension, time. Like the rapid jolting of the water tank, temporal

metamaterials can radically change their properties in the blink of an eye. This creates a kind of boundary that acts like a mirror in time – and it is this that exerts such subtle power over waves.

Not only are these materials a mind-bending invention, they have also become an unexpectedly rich playground in which physicists can test a raft of fundamental ideas at their limits. What happens when you send quantum particles through a slit in time? Does friction really exist in the quantum world? And can we execute an extreme test of special relativity? We are about to find out.

Though we may not give it much thought, we know that materials can manipulate waves. Mirrors reflect waves of light, while lenses can focus them. A straw in a glass of water looks bent, for instance, because the liquid deflects light, distorting the image. All of which has been understood since the 1600s, when Isaac Newton famously used a prism to separate sunlight into a rainbow. But few have considered what happens when the light-bending properties of a material are modified over time.

The story of how that changed begins with metamaterials – that is, materials engineered to have properties not found in nature. The most famous example is the "invisibility cloak" developed in 2006 principally by John Pendry at Imperial College London. The original version bent microwaves around an object so their trajectories behave as if it isn't there, and the concept spawned a raft of other metamaterials, including acoustic cloaks made of an ultra-thin sheet that can suppress the loudest bang. These are now being trialled in UK hospitals as portable screens between beds.

These inventions rely on nanoscale patterns etched into the material's surface. But a temporal metamaterial would instead depend on patterns in time. To be precise, that means changing its properties so fast that it appears to be instantaneous – creating something scientists call a temporal boundary.

This idea first occurred to electrical engineers studying the general properties of waves in the aftermath of the second world war, in which radio waves and radar had become a major research interest. In 1948, Dennis Gabor hypothesised that temporal boundaries could reflect and reverse waves. It went no further at the time. But fast-forward to 2016, and Fort, who is based at the Langevin Institute in Paris, had the idea of testing the hypothesis with water waves, which can be seen with the naked eye.

Give it a kick

He placed a water tank on a platform that could be moved quickly. "You give the bath a jolt with a shaker, you just give it a kick," he says. For a few milliseconds, the acceleration the water experiences changes, creating a temporal boundary. When the waves hit that boundary, they split into two: one part propagates forwards, the other is reflected backwards. The jolt effectively freezes, then releases, the wave. And when it is loosed, it has "forgotten" which way it was travelling, and so goes in both possible directions.

It looks eerily like a video playing backwards. And it was even more uncanny when Fort created complex images in the ripples. He used moulds and stencils to create ripples in the shape of a smiley face and the Eiffel tower (pictured, overleaf). These too would disperse and then reform, as if by magic.

Since Fort's proof of principle with the water tank, researchers have taken the idea and run with it, creating engineered temporal metamaterials that can manipulate acoustic and electromagnetic waves. One example, based on indium tin oxide, can almost instantly switch from being transparent to reflective.

These materials offer a completely new way of controlling waves of all types, and industry is clearly excited about where this could lead. In everything from microwave ovens to communications cables, the prospect of being able to more keenly control waves could be extremely handy. A research consortium called Meta4D was recently awarded nearly £8 million to develop temporal metamaterials – and companies such as telecoms giant BT are on board as partners.

Beyond the practical applications, these materials are opening up new ways to test ideas in physics that were previously out of reach. For instance, Riccardo Sapienza at Imperial College London was interested in putting a new spin on the famous double-slit experiment first ›

performed by Thomas Young in 1801. In the classic experiment, light was shone through two thin slits. The waves passed through each opening and spread out in a process called diffraction, before interfering with each other and creating a pattern of light and dark stripes on a screen. The experiment was taken as evidence that light can behave like a wave.

Sapienza and his team recreated this experiment with slits not in space, but in time. They created that indium tin oxide material, which can change from being transparent to reflective in millionths of a billionth of a second when hit with a laser. In 2023, the researchers shot two laser pulses at the material, creating two short windows during which light could pass through. They saw an interference pattern, but instead of changing the brightness of light, this experiment changed its frequency, or colour. No one had tried this before.

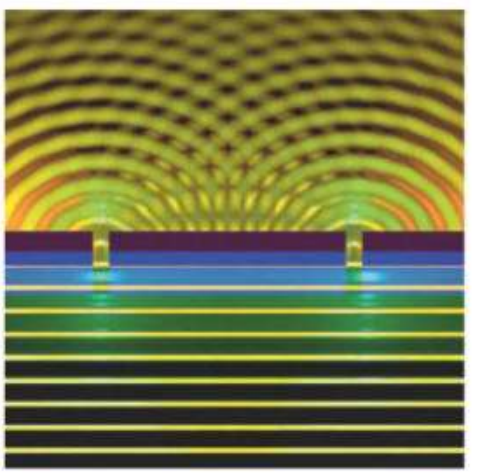
Changing the frequency of waves is crucial in all sorts of technology, but really challenging. For instance, radar signals are most efficiently sent at higher frequencies, but they need to be converted to lower frequencies when received by antennas. We currently use several pieces of technology for this; temporal metamaterials could offer a simpler alternative. "What really excites us is that we have a way of changing the way we think about how light interacts with a material," says Sapienza.

As well as remixing light, temporal metamaterials could help us test how it behaves when slowed to a dawdling pace, and so put Albert Einstein's special theory of relativity under the closest scrutiny yet.

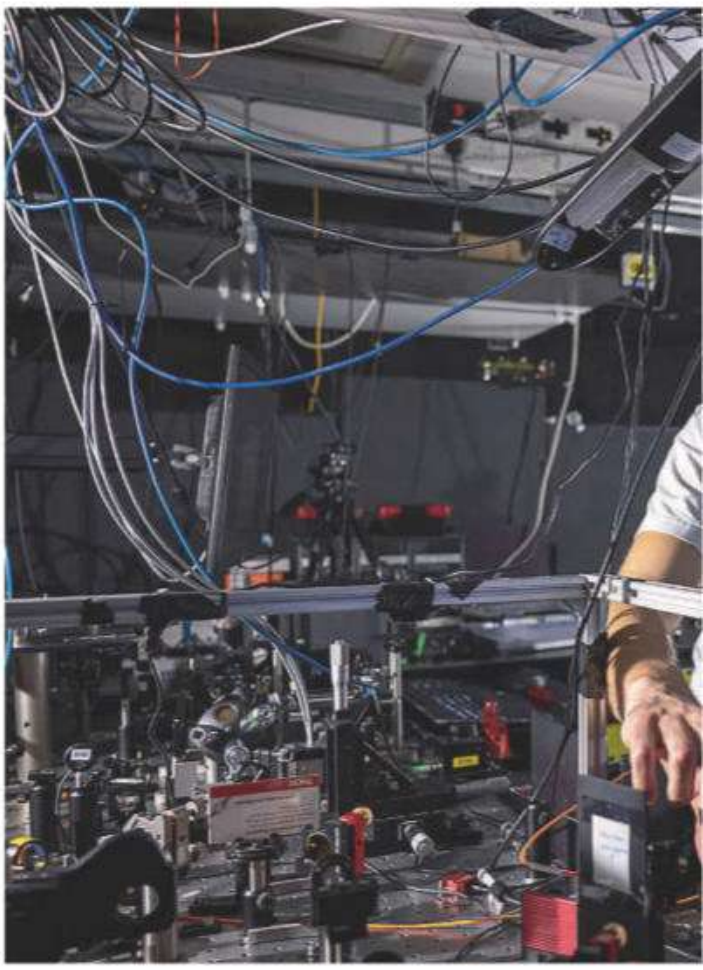
You may have heard that the speed of light is constant, which is true, but only in a vacuum. Light's velocity depends on the medium it is travelling through, specifically the material's refractive index, which describes its ability to slow (and bend) light rays. Light travels at around 300,000 kilometres per second in a vacuum, but only about 225,000 kilometres per second in water. The slowest recorded speed of light was clocked by researchers shining it through an ultracold gas in 1999 – it crawled along at 17 metres per second, about the speed of a car pulling onto a motorway.

But what happens when light shines through a moving medium? Augustin-Jean Fresnel wrestled with this question in 1818. He predicted that if light were passed through a material moving in the opposite direction, it would experience drag and slow down – think of it like a plane being pushed back by headwind. And he was right. Three decades later, the French physicist Hippolyte Fizeau split the sun's rays into two beams that he sent through streams of water flowing in opposite directions. The two beams were then recombined and the resulting interference pattern revealed that the light travelling against the current had indeed slackened in speed, albeit by a tiny amount.

The original double-slit experiment showed how waves interfere with each other (below). The "slits in time" version involved a sophisticated set of lasers (right)



RUSSELL KIGHTLEY/SCIENCE PHOTO LIBRARY



THOMAS ANGUS/IMPERIAL COLLEGE LONDON

"ALMOST NOTHING CAN CATCH A LIGHT BEAM, BUT THERE ARE WAYS OF SNEAKING UP ON IT"

What a drag

Einstein later showed that you could explain this "Fresnel drag" using the framework of special relativity. When the water moves with the light, the light's energy is added to the motion of the water, making the light appear to move faster. Conversely, if the water moves against the direction of the light, it subtracts from the light's motion, making it appear slower. But here's the thing: we have only ever tested this at fairly slow flow speeds – what if the light were travelling through a medium that was itself moving at close to the speed of light?

In 2019, Paloma Huidobro, then working with Pendry at Imperial College London, outlined how temporal metamaterials could finally test this. To get your head around this, think of a metamaterial's surface like a crowd doing a Mexican wave. The individual people are only moving up and down, but the collective action produces the illusion of sideways motion as the wave sweeps along.

In a temporal metamaterial, the things moving up and down at each point are properties such as permittivity, which determines how a material affects electric fields, and permeability, or how the material affects magnetic fields. As these properties vary, they create patterns that can ripple through the material's surface at extreme speeds. If a ray of light is then shone through the material, these ripples push back at approaching the speed of light. "Almost nothing can catch a light beam, the fastest object in physics, but there are ways of sneaking up on it," says Pendry. Sapienza

"IS QUANTUM FRICTION FACT OR FICTION? METAMATERIALS COULD SETTLE THE DEBATE"

says he has been working on making this "synthetic motion" work practically in the lab, and he is preparing to publish his results.

The applications of temporal metamaterials get even more far out. One of the strangest predictions of quantum mechanics is that a vacuum – that is, empty space – is never totally empty. Instead, it buzzes with "virtual particles" that flit in and out of existence. These are so short-lived that they are generally impossible to measure – but they do have effects.

In 1948, the Dutch physicist Hendrik Casimir imagined placing two flat surfaces close together in a vacuum. Those two plates, he thought, should be ever-so-slightly attracted to each other, even if they aren't electrically charged. This is because virtual particles are constrained from appearing and disappearing freely between the plates due to the limited space, creating a situation where there are more virtual particles outside the plates than between them. This results in a pressure between the plates, known as the Casimir effect.

The Casimir effect is real. But Pendry goes further. Years ago, he proposed that the pressure on the plates should create friction between them if they are moved, even though they aren't touching – quantum friction. However, the idea has long been deeply controversial. Ulf Leonhardt at the Weizmann Institute of Science in Israel, for one, gives it short shrift. He claims that, if it were true, it would be possible to extract limitless useful energy from the chaos of those virtual particles within the vacuum.

So, quantum friction: fact or fiction? Metamaterials present a way to settle the debate, says Mário Silveirinha at the University of Lisbon in Portugal. Quantum friction should result in the emission of particles of light, but these photons would only be produced in detectable amounts if the plates were "rubbed" at incredible speeds. So Silveirinha's plan is, again, to employ synthetic motion. Imagine two metamaterials next to each other in a vacuum, with ripples running along them at a sizzling pace. It would be as if the plates were moving with respect to each other. If photons are given off, that would be strong evidence in favour of Pendry's hypothesis.

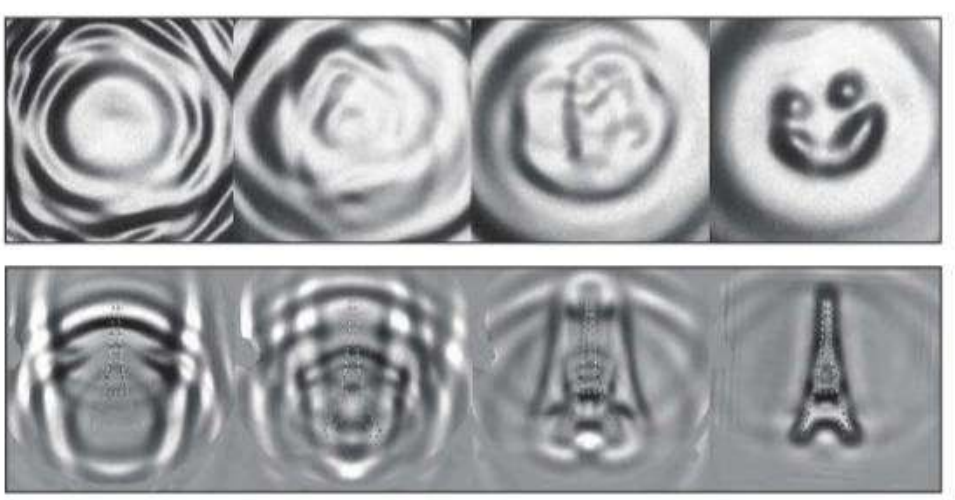
"This is a very promising way to test quantum friction," says Silveirinha, who is now working with experimentalist colleagues to try it. He points out that this experiment isn't just to settle an academic curiosity. If quantum friction exists, it has powerful applications: he imagines a laser powered by synthetic motion. The photons that would be created by quantum friction would usually just be reabsorbed back into the vacuum whence they came. However, if the relative velocity between our two metamaterial surfaces is high enough, we could create so many that they would splurge outwards. These photons would be emitted at frequencies in the terahertz range, says Silveirinha, which straddles the point between infrared radiation and microwaves. Lasers that operate in this region are currently extremely difficult to make.

Pesky causality

For the moment, though, many of the ideas around time-varying metamaterials are in their infancy. While physicists have developed a suite of analytical tools to help them understand wave behaviours in different spatial configurations, time presents a fresh challenge. Theorists are rushing to meet this, struggling to overcome mental blocks concerning time boundaries. "Time is a fundamentally different dimension to space because of causality," says theorist Simon Horsley at the University of Exeter, UK, who is among those grappling with these issues. "You can't have processes travelling backwards in time, so this is the headache of understanding a lot of the effects in these materials."

Even in Sapienza's "slits in time" experiment, there are questions over how to interpret what is going on. The material that his team used was able to change its properties much faster than expected, and the researchers don't fully understand why. "It's not so intuitive, I think," says Sapienza. "If I tell you light interacts with a material in space, you can see with your eyes that it goes in different directions. But when I tell you that light interacts with a blip in time, it's very hard to have an intuition."

With all that in mind, we are in for an exciting period in the world of temporal metamaterials. Fort says that the response to his 2016 experiment with the water tank was huge. Even though the idea of reversing waves had been around for decades, seeing the water ripples rewind was profound and beautiful, he says. "Even theoreticians see it and go: 'Wow. It's true, it's all really true.'" ▮



EMMANUEL FORT ET AL. (2016)

Images of a smiley face and the Eiffel tower were created with ripples that then dispersed and reformed in a milestone experiment

Jacklin Kwan is a science writer based in London

The back pages

Puzzles
Try our crossword, quick quiz and logic puzzle p45

***Almost* the last word**
Is it more eco-friendly to keep an old car or buy a new EV? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
Canine contributions, plus a mustache mix-up p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

Debunking gardening myths

Hold the milk

Social media is adamant that you can fertilise your houseplants with milk, but **James Wong** will be saving his for a hot drink

James Wong is a botanist and science writer, with a particular interest in food crops, conservation and the environment. Trained at the Royal Botanic Gardens, Kew, in London, he shares his tiny flat with more than 500 houseplants. You can follow him on X and Instagram @botanygeek

IF YOU are a gardener who has been on any social media platform in the past five years, you will have seen them: dozens of posts extolling the virtues of using milk as a magical ingredient to transform the health of your houseplants. Now, you don't have to be a botanist like me to think this might not be the best idea. But science is all about trying to stay as objective as possible, so I decided to comb through the evidence to challenge my preconceptions.

Given how many times I have seen this idea circulate online, I have yet to see a single meme cite a study to back it up. Trawling through the academic databases I soon found out why. There really don't seem to be any well-designed scientific experiments published on the subject. Occasionally, you see a reference to this being an "ancient practice", but a search of historical sources also failed to turn up anything.

In fact, the earliest reference I could find to this idea was from 2002, when Nebraska steel industry executive turned dairy farmer David Wetzel started spraying waste skim milk on fields and noticed the grass seemed healthier. If 2002 is "ancient", I really do feel old, but it was in these articles that I saw the only reference to solid data on the subject. It was in quotes from University of Nebraska scientist Terry Gompert on an experiment he ran. His study never seems to have been published, but it is plausible that milk could be a good plant food.

EKATERINA SAVYOLOVA/GETTY IMAGES

In fact, milk is a rich source of protein, which is built using nitrogen – a key plant nutrient needed for healthy leaves. It also contains phosphorus, essential for root growth, as well as calcium and a range of other minerals too. However, by and large, this is really the case for any organic material, plant or animal. Once decomposed by bacteria and fungi, the minerals are returned to the soil for plants to take them up again in a never-ending cycle. So is milk somehow superior to conventional fertilisers?

Skimmed milk, as apparently tested by Gompert, contains about 3.1 per cent protein, which in turn is about 16 per cent nitrogen. That makes a solution containing 0.5 per cent nitrogen when used undiluted. Standard liquid feeds, by comparison, contain around 15 per cent nitrogen. But the nitrogen in milk is only available to plants after decomposition by bacteria and fungi in soil. Not only are these microbes not often present in potting mix for houseplants, but when they are, they also produce an almighty odour.

Finally, let's look at cost. The store-bought houseplant food on my desk works out to about £0.17 per litre when diluted. Meanwhile, the milk in my fridge cost £1.06 per litre. This makes milk six times as expensive, while delivering fewer nutrients, in a less accessible form, with a more than pungent aroma. ▮

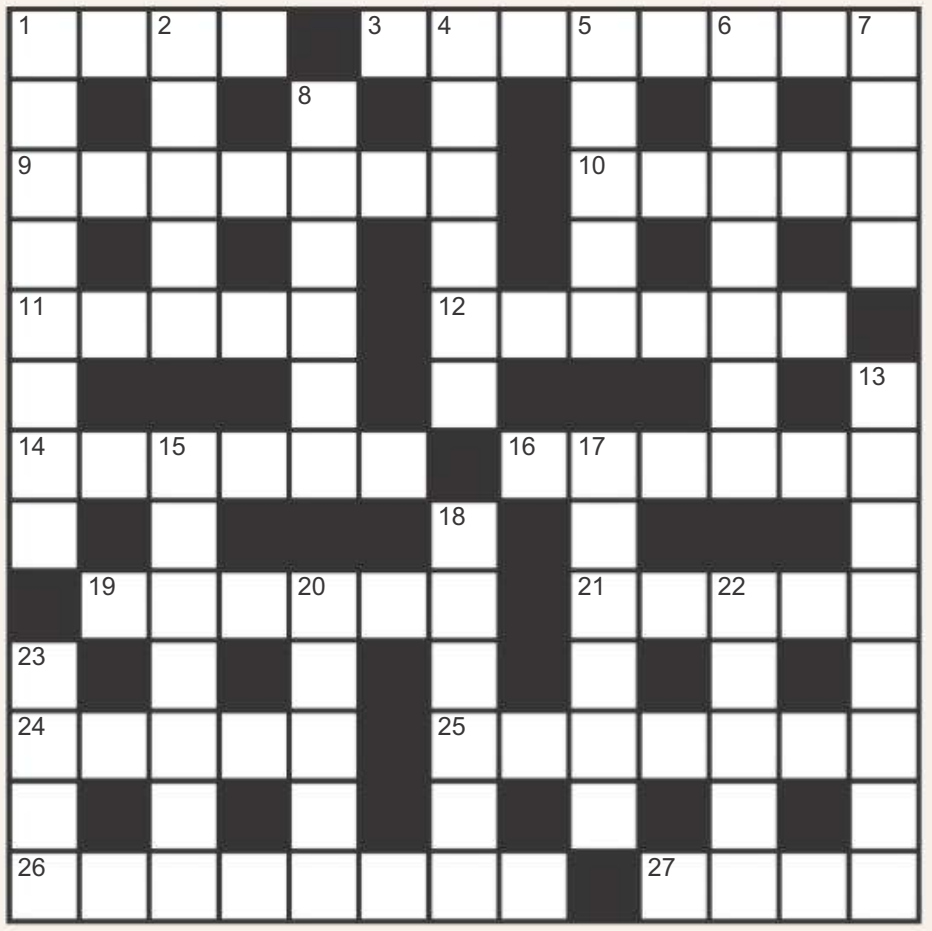
These articles are posted each week at newscientist.com/maker

Debunking gardening myths appears every four weeks. Share your gardening successes with us on X and Instagram @newscientist, using the hashtag #NewScientistGardening

Next week

The science of baking

Cryptic crossword #137 *Set by Trurl*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Picture one dropped – it might be busted on floor (4)
3 Samphire prepared by angelic types (8)
9 Turnaround of Slack? (4,3)
10 Scandals start with you and me greeting Asian dish (5)
11 Loud primate decapitated to get bone (5)
12 One with pouch where baby develops late, internally (6)
14 Gone, destroyed, cut by axes? We need it to breathe! (6)
16 Smartphone ultimately controlled by thumb (2-4)
19 Pitch twice for plaque (6)
21 Buzz surrounding fair is nonsense (5)
24 Unit of the Royal Marines (5)
25 Peaceable sort of movie, not scary (at first), screened by fundraiser (7)
26 Wood supports and presses (8)
27 Both sides going after postgrad for earthy material (4)

DOWN

1 Turkey, on a large scale, completing thousands of operations (8)
2 Space beneath type of car engine to make revving noise (5)
4 Small bird: the Spanish hen, possibly (3,3)
5 Last bit of tea service overturned – get more tea! (5)
6 Henry with price of stamp, minus a penny he's taken (7)
7 Imam misrepresented, causing damage (4)
8 Swimming ashore with a frog? (6)
13 It's funny, with one gas replacing another – nitrous oxide, perhaps! (8)
15 In late December, ached, having a slight twist (4-3)
17 Shaken, having dropped sulphur, and owing money (2,4)
18 Head saw partner almost in pieces (6)
20 Watch Berners-Lee, perhaps, on what's central to internet (5)
22 Writer Kelvin away from keyboard area (5)
23 Fiery Sicilian raising cash for gambling (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #255
set by Bethan Ackerley

1 The upper part of Earth's mantle, lying directly beneath the lithosphere, is also known as what?

2 The Challenger expedition, a 19th-century oceanographic voyage, set sail in which year?

3 In geology, a rock's tendency to split along flat planes of weakness is known as its what?

4 Which of the following scientists has never worked at Bell Labs in New Jersey: Charles K. Kao, John Bardeen or Vera Rubin?

5 The name "white vitriol" has historically been applied to what compound?

Answers on page 47

BrainTwister
set by Colin Wright (with thanks to Peter Winkler)

#23 Four points, two distances

When you have four distinct points arranged on a flat surface (such as coins on a table) there are six possible pairs and hence six possible distances you could measure between pairs of points. It is possible to arrange the points (or coins) so that all six distances are different.

It isn't possible to make all the distances the same – but can you arrange them in a way that only uses two distances?

Once you have found one arrangement that uses only two distances, can you find a different one?

How many arrangements that use two distances can you find in total?

Solution next week

Electric dreams

Is it more environmentally friendly to keep my 23-year-old petrol car or to scrap it and buy a new electric one? I drive about 8000 kilometres a year and am quite old, so my car may outlast me.

Stephen Johnson
Eugene, Oregon, US
While the general idea of replacing an old petrol car with an electric car has environmental benefits, there are many issues that make it unlikely this is a wise decision in this particular case.

Looking first at the issue of carbon, a new electric car requires around 6 tonnes of carbon for its manufacture. During operation, an electric car produces about 94 grams less carbon per kilometre than a petrol car. So, to recover the carbon burden of the electric car's production, the reader would need to drive their new car 65,000 kilometres, or for around eight years at their current rate of driving.

A new electric car has many other environmental issues, in particular its need for the mining of lithium, copper and cobalt. All of these elements cause serious environmental, political and physical harm at every level of their extraction and refinement.

"To help the environment, the best transportation change any of us can make is to use mass transit when possible"

To help the environment, the best transportation change any of us can make is to use mass transit when possible, use bicycles and electric bicycles for short trips and try to plan our car trips to include as many of our weekly errands in a single trip as possible.

Matthew Wenban-Smith
London, UK
It is most environmentally friendly to reduce the kilometres you drive, ideally to zero. But assuming that you have already minimised this, then in relation to climate change at least, you should scrap (and not sell for continued use) your old car and replace it with the most efficient electric one immediately.

The good news is that once you have got rid of your old car, your own longevity is no longer relevant, unless you are planning on being buried with your vehicle.

The basic calculation is whether the greenhouse gas emissions per kilometre for your new electric car, over its whole lifetime in use (and including the emissions associated with the extraction and processing of the materials it is made of), will be less than the current emissions per kilometre of your petrol car. For your current car, ignore historical emissions – I am afraid that is a sunk cost.

But really there's no need to do the calculation – a new electric car is sure to have lower emissions per kilometre, on this basis, than your current petrol car.

It is the same calculation you would make to replace an old incandescent light bulb with a new LED one – you should do it immediately, and not go on heating up the planet while you wait for your old bulb to stop working.

David Gregory
Via Facebook
The "payback" for an electric vehicle is generally between 24,000 and 32,000 kilometres. Once it is past this threshold, it is then better than any petrol or diesel car, no matter what miles per gallon you are getting.

An easy way to speed up the "payback" process is to buy an electric vehicle second hand that has already covered 32,000 kilometres or more.

Terry Gillen
Tring, Hertfordshire, UK
I am in my 70s, my car is 19 years old, I also drive about 8000 kilometres a year and I want to be environmentally conscious. So, asking the same question as your reader, I have researched extensively and concluded that keeping my old car is more environmentally friendly than buying an electric one.

This is for three main reasons: first, the manufacture of electric cars has such a big carbon footprint that it can take over 60,000 kilometres of driving (less if electricity is generated from renewables) to "break even" environmentally; second, the rare earth metals used in electric car batteries are extracted by strip mining, which has a detrimental effect on about 500 square kilometres of adjacent land; third, those mines are often in countries with dubious records on pollution and employee rights.

Consequently, I decided to keep my old car, reduce the amount of driving I do, maintain it well and follow advice for obtaining maximum miles per gallon.

IVAN KMIT/ALAMY

Are spider's webs made of the same stuff the world over?

This week's new questions

Incy wincy **Is the chemical composition of spider's webs the same all over the world, or has it evolved differently in separate locations?** ***Carl Parker****, London, UK*

Room to remember **If someone could have their life extended with no limit, would their brain eventually run out of storage space?** ***Tony Lang****, Epsom, Surrey, UK*

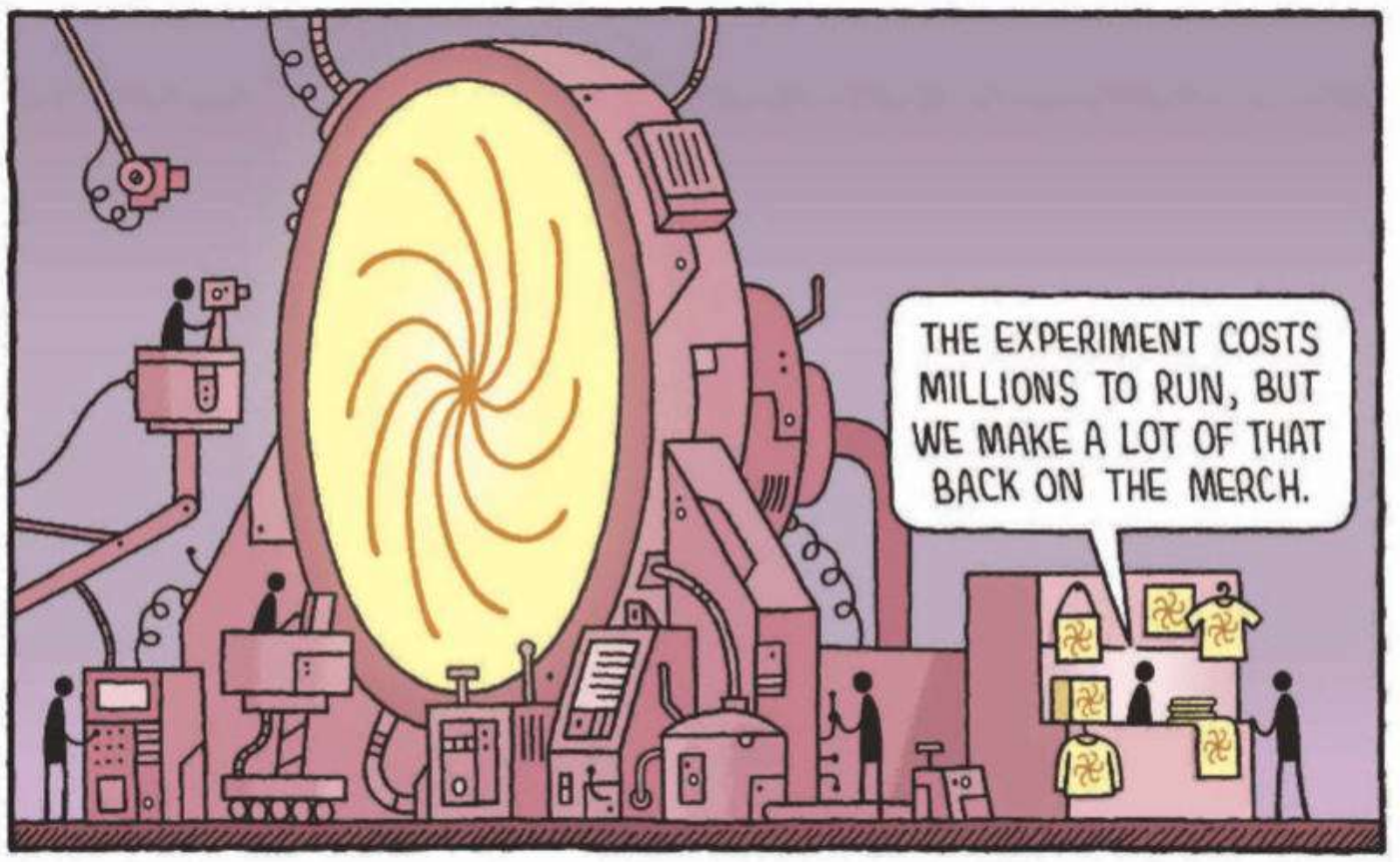
Ironed out

Why is it harder to remove a crease from a shirt with an iron than to put one in?

Mark Wareing
Ashbourne, Derbyshire, UK
When a crease is ironed in, the folded cloth lifts the iron slightly from the surface along the crease, and the heat and weight of the iron is more concentrated along the new crease. When simply

Want to send us a question or answer?
Email us at lastword@newscientist.com
Questions should be about everyday science phenomena
Full terms and conditions at newscientist.com/lw-terms

Tom Gauld
for New Scientist



ironing to remove general creases, the heat and weight of the iron are spread out more evenly, making it less effective. Another factor is the water sprayed over the surface to ease the breaking and re-forming of hydrogen bonds in the cloth during ironing. For general crease removal, the applied water tends to be more patchy, and ironing is less effective in the dryer patches.

Chris Daniel
Glan Conwy, Conwy, UK
Whatever the answer is to this question may explain why the creases that appear on my face every year never seem to go away.

Best thing since

What is the best way, and best knife to use, to minimise crumbs when slicing bread, particularly wholemeal? (continued)

Robert Gray
Via email
For many years, I have used a sharp, finely serrated bread knife. It has been quite acceptably

"I knew someone who would use a band saw to cut frozen bread straight from the freezer, but this isn't always the right tool"

cutting my home-baked wholemeal bread, producing a modest amount of crumbs. But inspired by this question, I experimented and found that our sharp, unserrated carving knife works a lot better. It cuts easily with almost no crumbs. So from now on, our serrated bread knife is relegated to the back of the drawer. The crucial thing seems to be sharpness: if the blade is really sharp, it will cut bread perfectly well; a blunt knife will cut badly and make a lot of crumbs whether or not it is serrated.

I did know someone who had a woodworking workshop next to his kitchen and would use a band saw to cut frozen bread straight from the freezer. But if your bread is already in an eatable condition, a saw isn't the right tool.

Joe Watson
Cirencester, Gloucestershire, UK
The crust on the top of a loaf is the hardest part. Bread knives are typically serrated in order to facilitate cutting through this hard crust. Unfortunately, the serrations on the knife produce a lot of crumbs when cutting through the rest of the loaf. I haven't used a serrated bread knife in over 40 years because of this.

Instead, I use my plain-bladed carving knife, which I keep very sharp. However, don't try to cut down through the hard crust on top of the loaf because the lack of serrations on the blade makes this very difficult.

To get around this, I turn the loaf on its side. This has two advantages. Firstly, the side of the loaf is much softer than the crust on top, so the knife cuts through it more easily and less force is needed. Secondly, a tall narrow arch is much stronger than a shallow wide one, so the loaf is structurally stronger to take the force of the knife pressing down on it. ▮

Answers

Quick quiz #255 *Answers*

1 The asthenosphere
2 1872
3 Fissility
4 Charles K. Kao
5 Zinc sulphate

Quick crossword #159 *Answers*

ACROSS 9 Binocular vision, **10** Scorpio, **12** Auricle, **13** Pyrolysis, **14** Clock, **15** Dead end, **18** Ciliary, **21** Ovine, **23** Anamnesis, **25** Synergy, **26** Ammeter, **29** Archimedes screw

DOWN 1 Ibis, **2** Undo, **3** Scapulae, **4** Alloys, **5** Triassic, **6** Citric, **7** Cinchona, **8** Enter key, **11** Clyde, **15** Doomsday, **16** Avionics, **17** Dialyser, **19** Landmass, **20** Raise, **22** Earwig, **24** Azalea, **27** Turn, **28** Rows

#22 Even rows *Solution*

There are lots of solutions, and each condition is a subset of the previous. The exact arrangement of the numbers doesn't matter too much – only where the odd and even numbers are. For example, this is one that meets all three criteria.

16	1	2	15
3	4	7	6
5	12	9	10
14	11	8	13

Pet participation

What can dogs offer, tangibly, to a city? An answer is forthcoming.

Reader Dorothy Sheckler alerts Feedback that on 22 July 2024, at a Soil and Water Conservation Society conference in Myrtle Beach, South Carolina, Brad D. Lee of the University of Kentucky will present his views. Lee's listed topic? "Companion canine nutrient contributions to peri-urban environments".

During the talk, tensions may be discernible, because the host city has announced that dogs are allowed on the beach only before 10am and after 5pm this summer, and that owners "must pick up and properly dispose of the droppings".

Mussel-bound death

Detective work and international cooperation have led to the rediscovery of a long-forgotten duo of preserved corpses.

Biologist Kees Moeliker, a scholar of surprising animal behaviour (he discovered homosexual necrophilia in the mallard duck, as per Feedback on 10 February 2024), tells us what happened.

"Dramatic is the fate of a Danish black-headed gull (*Chroicocephalus ridibundus*) that stepped on a freshwater mussel in 1952," he writes. "The mussel closed its valves and would not let go. The (no longer living) evidence – the gull itself with the mussel still attached to its right leg – was on display in an old photo I found deep in the internet."

KEES MOELIKER

Moeliker learned that the photo had been taken at the Museum of Hunting and Forestry in Hørsholm, in the east of Denmark. In 2017, that museum became part of, and was moved to, a different institution now known as the Green Museum in Auning, in the west of Denmark. As happens with any large, variegated museum collection, some treasures resided there safely but virtually unnoticed. Moeliker got in touch with the Green Museum's curator, who plucked the twin item (officially labelled JSH 05542) from obscurity on the long shelves of a carefully chilled building.

"In April 2024, I was allowed to view the black-headed gull in the museum's collection storage facility, and to make this photograph," Moeliker continues (see left). "There I learned more: the gull had not been killed by the mussel's embrace, but had been shot – with the attached mussel and all – near Sorø in Sjælland [Denmark]. Also special, in that same Danish collection, is item JHS 05924: the single leg of a herring gull found in 1954 trapped in a half-opened tin can."

Twisteddoodles *for New Scientist*

OOH THIS MODEL IS QUITE HOT
CLICK THAT ONE
NOT AS HOT BUT STILL GOOD
CHECK OUT THAT ONE
HOT BUT HAS WIND
WHAT ARE YOU LOOKING AT?
WEATHER PREDICTION MODELS
@twisteddoodles

Got a story for Feedback?
Send it to feedback@newscientist.com
or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

Mustache negation

Feedback consulted a native (and, as needs be specified in the ChatGPT era, human) Iranian translator to solve a hairy mystery. A curious phrasing appears in the titles of several studies published recently in research journals in Iran. What follows are are three examples.

"Analysis of the economic diplomacy of the Islamic Republic of Iran in international relations with an emphasis on the rule of negation of the mustache", published in *Strategic Studies of Jurisprudence and Law*.

"The legal jurisprudence explanation of the display of power and the increase of Iran's military defense capabilities with an approach to the rule of negation of the mustache", published in *Protective and Security Researches*.

"The role of the mustache denial rule in the foreign policy of the Islamic Republic and international relations", published in the *Iranian Political Sociology Journal*.

Each paper is written in a mix of Farsi and Arabic, and includes an abstract written in English. Each abstract, like each title, includes a mention of "mustache".

Why mustache? Feedback's language consultant, astonished, explains: "Because the paper's translator is a complete dunce!! In Arabic, the word for 'a way [of doing something]' is sometimes called *sabil*. In Persian [Farsi], *sibil* means "mustache". Maybe the translator is simply Google."

The world will now see what influence these mustachioed papers have on international diplomatic relations.

Mustache measuring

While pursuing the intricacies of the rule of negation of the mustache, Feedback happened across a (probably unrelated) study published in 1982, called "Survivorship curves and growth rates for a population of mustache hairs". Written by Cliff Frohlich and Ruth Buskirk, it reports "measurements of three characteristics of mustache hairs which apparently have not been studied previously, namely, the distribution of hair lengths, the rate of hair growth, and the rate of hair loss, or weathering" – all this in "the untrimmed mustache of a 30-year-old Caucasian male".

Eleven years later, Frohlich cited that mustache paper in a study, published in the *Journal of Geophysical Research: Solid Earth*, about some mathematical subtleties in measuring the intensity of earthquakes. He pointed out that, like mustache-hair growth, "earthquakes are simply one of a host of phenomena for which logarithmic plots of number versus size are approximately straight". ▮

Marc Abrahams

Holy SH**!

Or perhaps that should be "Unwholly SH21"? Because to mark the 10th anniversary of our five-day chronometer movement, Calibre SH21, we've subjected it to open-heart surgery. Between The Twelve X (Ti)'s front and rear sapphire crystals, we've re-forged and skeletonised components with custom-made, diamond cutters. Then sculpted them to a precise, polished finish using re-programmed state-of-the-art CNC machinery. This industrial evolution extends to the outside with a 41mm case made from Grade 2 and Grade 5 titanium. Its top ring is rhodium. And it premiers a new micro-adjustable bracelet. When you find out how much it costs, we swear you'll love it. (And maybe utter the odd expletive yourself.)

Do your research

Christopher Ward

christopherward.com

omegawatches.com

SPEEDMASTER MOONWATCH
Co-Axial Master Chronometer

PRECISION

Our attention to detail is evident in everything we make. It took our skilled watchmakers years to create this delicate dance of levers, jewels, and wheels. OMEGA's extraordinary Co-Axial Calibre 3861. A movement Master Chronometer certified for its exceptional precision, performance, and magnetic resistance. We achieve this level of excellence by investing time and obsessing over the details. That's our uncompromising approach. That's OMEGA precision.

OMEGA

#Precision